Smithsonian Tropical Research Institute

2002 Meteorological and Hydrological Summary for Barro Colorado Island

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Introduction

This is the nineth of a series of yearly reports summarising the past year's Smithsonian Tropical Research Institute's Terrestrial-Environmental Sciences Program (T-ESP) Meteorological and Hydrological Monitoring Program on BCI. This report is not meant to be exhaustive in its coverage in that it summaries only some of the most 'important' or interesting parameters available. Any comments on how future yearly summaries could be improved would be appreciated.

Setting

The meteorology and hydrology monitoring programs on BCI are described in detail in Climate and Moisture Variability in a Tropical Forest: Long-term Records from Barro Colorado Island, Panamá. Windsor (1990). Much of the information on the next five pages has been extracted from this source.

BCI (9°10'N, 79°51'W) is a completely forested, 1567 ha island with a 53.9 km perimeter, rising 137m above Lake Gatun. The island receives an average of 2634 mm of rain per year**.** The meteorological year is divided into two parts: a pronounced dry season (approximately from mid-December to the end of April), and a wet season (May to mid-December). On average, only 293 mm of rain falls during the dry season. Relative humidity, soil moisture, air pressure, solar radiation, evapotranspiration, wind speed and direction all show marked wet/dry season differences. On the other hand, temperature varies relatively little throughout the year.

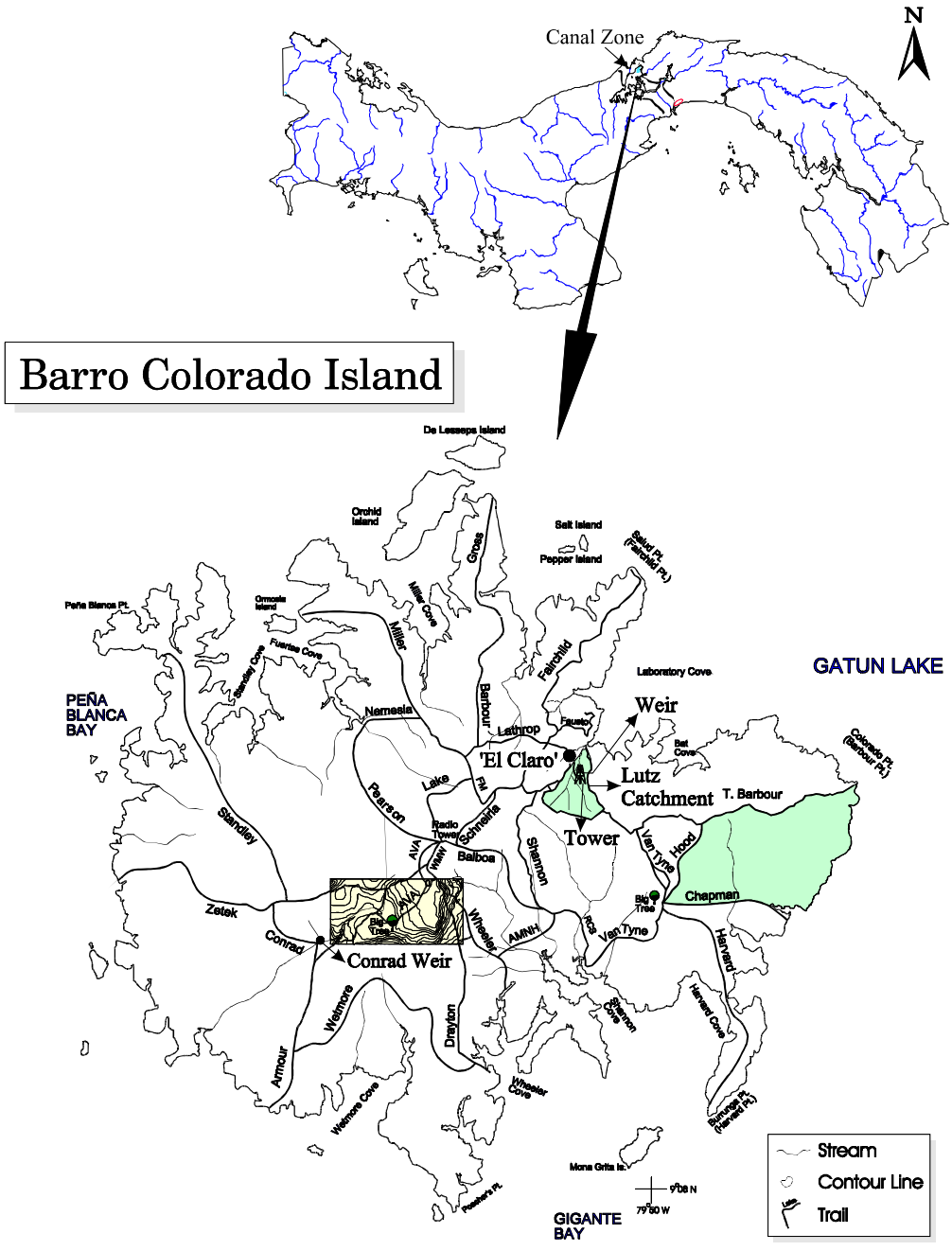
This report summarises data taken from two locations: a 48 m walk-up tower located within the Lutz catchment, and a small clearing ('El Claro') located among several laboratory buildings (see map on the following page). The tower, with sensors at 10 m intervals, provides a vertical meteorological transect through the forest canopy. The Lutz catchment, located on the Northeast slope of BCI, and is probably typical of many small catchment areas on the island. The catchment encompasses 9.73 ha. The Lutz catchment is located immediately southwest of the laboratory clearing and dormitory area. The Clearing is a grass-covered area located near several laboratory buildings.

The physical aspects of both the Clearing and the Tower have changed relatively little over time. However, cycles of vegetation removal and re-growth may have had subtle effects at both locations. The recent removal and construction of buildings near to the Clearing may also have affected the local climate. Furthermore, it is evident that the canopy surrounding the Tower has risen, perhaps by as much as 5m, since the Tower was erected – with possible measurement implications, especially at the highest levels.

In October of 2002, three new, 6-foot sections were added to the top of the tower. It was necessary to remove many banches from trees next to the tower during this operation. The new maximum height of the tower is approximately 48m. A parallel series of

meterological measurements are now being made a both the old maximum height and the new. The exceptions to this will be: wind direction (it's now not possible to measure at the old height), and solar radiation (assumed to be unaffected by the change in height).

Data were collected using two different methods: electro-mechanically (electronic sensors, data loggers, chart recorders, etc.), and manually (rain gauges, max-min thermometers, sling psychrometers, soil samples, ETGages) by a technician - Mr. Raúl Ríos. In general, manual readings tend to provide the most accurate measurements over the long-term and, as a result, when both types of data are available, the manual readings are used in this report. Some of the disadvantages of these measurements are that they are not available for every day, and they are usually taken only once a day (once a week for soil samples).



Some summaries (temperature, relative humidity, and soil humidity) are based entirely on manual measurements. Other summaries (solar radiation, wind direction) are based entirely on electro-mechanical measurements. Finally, some summaries (rainfall and wind speed) are based on combinations of manual and electro-mechanical measurements.

The Data

This report summarises the following data:

Lutz Tower	1m	relative humidity
		temperature
	40m	evapotranspiration
		relative humidity
		temperature
		wind speed and direction
	48m	evapotranspiration
		solar radiation
		relative humidity
		temperature
		wind speed and direction
Lutz catchment		run-off
		soil moisture
'El Claro'		evapotranspiration
		rainfall
		relative humidity
		temperature

Rainfall

Rainfall was collected by rain gauges in the Clearing, and by tipping buckets in both the Clearing and near the Lutz weir. The rain gauges were read at approximately 9:00 am every day except weekends and holidays. Tipping buckets provide continuous rainfall information, but tend to underestimate total rainfall by between 2% and 12% and for that reason are not used to provide data on absolute rainfall totals. Tipping buckets generate 'events' for every 0.254 mm of rainfall recorded. The underestimation seems to be due to the instruments' inability to properly record intense periods of rainfall. In order to 'fill in' the missing rain gauge data, a computer program was written by the author that uses tipping bucket rainfall data to distribute the rain gauge data for those days when readings were not made. The program takes the total rainfall collected in the rain gauge and divides it up proportionally according to the rainfall patterns recorded by the tipping bucket. The

estimated rainfall for the missing days is exactly equal to the rainfall collected by the rain gauge. The daily rainfall for the Clearing is shown on page 8.

Page 9 shows the monthly totals for this year. The graph on the same page compares this year's monthly totals with the average monthly totals (±SD) for the period 1929 to 2001.

Page 10 shows yearly rainfall totals for all year since 1925. Time series graph and frequency histograms are presented for these data.

Page 11 breaks yearly rainfall approximately into wet and dry seasons. The average beginning and end dates for the seasons as defined by the PCC (Dec. 20 and May 2) were used. The two graphs on this page are frequency histograms showing the distribution of rainfalls (1929 to 2001) for the Dry and Wet Seasons. The arrow ⟶ in each graph shows the rainfall for 2002 in relation to previous years. The small crossbar —|— above each graph represents the mean (vertical bar) and the standard deviation (horizontal bar) for the period 1929 - 2001.

Page 12 shows the beginning and end dates of the Panama Canal watershed dry season as defined by the Meteorological and Hydrological Branch of the Panama Canal Authority (PCA). The PCA defines the existence of dry season by tracking 11 variables (see list below). There are no publications justifying the use of this system and any questions should be directed to Mike Hart of the Met. & Hyd. Branch of the Panama Canal Authority. The data from Page 11 are shown graphically on Page 13.

Westerly Component of 300 HPA Wind
Gatun Lake Basin evaporation > 0.13" day^{-1}
Sea temperature at Amador < 80 °F
< 5 grams of water vapor kg^{-1} below 12,00 ft
Temp-Dew point difference SFC-400 HPA., > 10°C
Howard Airforce Base wind speed SFC-4000 ft., > 15 knots
Inter-Tropical Convergence Zone > 2 deg. Lat. south of Panama
Pacific Coast sea breeze < 2 hours day^{-1}
Atlantic Coast surface wind average > 6.0 M.P.H.
Gatun Lake level (corrected for water usage) falling
Gatun Watershed daily rainfall average (of 26 stations) < .25"

Pages 14 and 15 show an analysis of rainfall 'events' (*storms*). For convenience, and again somewhat arbitrarily, I have defined a storm as any continuous period of rain separated by at least an hour from any other rainfall. Since this analysis required the timing of rainfall events, tipping bucket data were used. As a result, the absolute size of rainfall events should be considered as only an estimate since they will tend to disproportionately underestimate the size of storms - larger storms will be more underestimated than smaller ones. Keeping this in mind, the tables and graphs on this page compare the maximum storm size and the average storm size and duration per month for the period 1972 to 2001 and for the year 2002.

Run-off

Run-off at the Lutz catchment area was determined from the water level in a 120° V-notch weir. The height of the water was recorded by two separate instruments: continuously by a Stevens A-71 strip-chart, water level recorder and at five-minute intervals with an ISCO Bubble Flow Meter. Data from these devices are converted (either directly or through a digitizing process) into run-off (m^3) and then into rainfall equivalents.

Daily Lutz creek weir run-off totals are shown on page 16. These data are shown in terms of the equivalents of precipitation in mm. These values are calculated by taking the run-off and dividing by the total surface area of the catchment area (9.73 ha). In this way, the run-off can be more conveniently compared to the amount of rainfall.

Pages 17 show the total monthly run-off. The graph on the bottom of page 18 compares average monthly run-off for the period 1973 to 2001 with 2002. The graph on the top of page 18 compares monthly accumulated precipitation with 2002 and long-term monthly accumulated run-off (in rainfall equivalents).

Soil Moisture

Soil moisture was determined gravimetrically based on samples collected every two weeks. Samples are taken at two depths (0-10cm and 30-40cm) from ten sites in the Lutz catchment area. Samples of approximately 2.5 cm soil cores are made with an 'Oakfield punch'. Page 19 shows the average soil moistures (% water by wet weight of soil) per month at each sample depth. The graph on the same page compares monthly averages for the period 1986 to 2001 with those for 2002.

Relative Humidity

Relative humidity was measured using the traditional method of wet and dry-bulb psychrometry. Measurements in the Clearing, at the base, middle and top of the Lutz tower (1m, 20m and 40m, respectively) were made at approximately 12:30 p.m. using a Taylor Sling Psychrometer. Data were also collected on an hourly basis by dataloggers attached to newly installed Vaisala electronic temperature/humidity sensors. These data are not reported in this yearly summary.

The average monthly relative humidities are shown in tabular and graphical form on pages 20 and 21, respectively.

Temperature

Shaded air temperature was measured in the Clearing, at the base and the top of the Lutz tower by Taylor max-min thermometers. Measurements were made by hand at

approximately 830 am. Data were also collected on an hourly basis by dataloggers attached to Vaisala electronic temperature/humidity sensors. These data are not reported in this yearly summary. The average monthly maximum and minimum temperatures for these three locations are shown in tabular and graphical form on page 22 and 23, respectively.

Solar Radiation

Global solar radiation was measured at the top of the Lutz tower using a Li-Cor LI200SB pyrranometer attached to a datalogger. Hourly total (KJ m^{-2}), maximum and minimum (J m^{-2} s^{-1}) were recorded. A Li-Cor 190SB sensor recorded Photosynthetically Active Radiation (PAR) similarly.

Page 24 shows the Daily Global Radiation values and Page 25 shows the Daily PAR values for 2002. Page 26 shows total monthly Global Radiation and PAR.

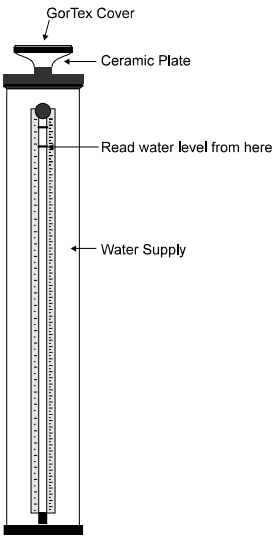
Wind Speed and Direction

Hourly average, maximum and minimum wind speed plus average wind direction was recorded at the top of the Lutz tower using a Model 05035 Young Anemometer connected to a data logger. Total wind passage was recorded on working days at approximately 9:30 am using an analogue totalizing anemometer. This device is believed to be more accurate than the Young Anemometer, especially during periods of low wind speeds due to totalizing anemometer's lower wind-speed threshold.

Page 27 shows the average and maximum daily wind speeds from the Young Anemometer. The page 28 shows average wind direction. The angles indicated in the table and graph on this page represent the direction from which the wind was predominately blowing on a given day. Page 29 shows the monthly average wind speeds (based on the totalizing anemometer) and directions for the year.

Estimated Evapotranspiration and Water Balance

ETguage



Evapotranspiration was added to the meteorological program on BCI beginning on December of 1992 and is estimated using ceramic plate atmometers known as ETgages. ETgages estimate evapotranspiration by allowing water to be drawn up through a ceramic disk and out through a GorTex cover. A recent study by Fontain and Todd (Measuring Evaporation with Ceramic Bellani Plate Atmometers, 1993, Water Resources Bulletin, Vol. 29, No. 5, p. 785-795) found that such devices perform very well compared with more traditional methods of measuring evaporation.

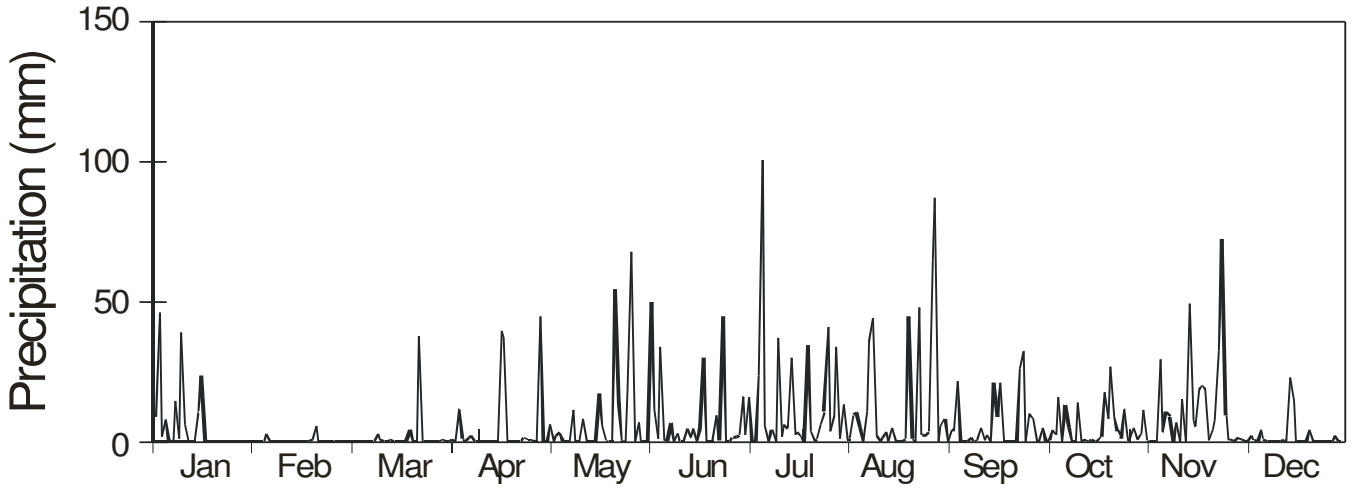
There are two ETgages currently being used on BCI: one in the Clearing located at a height of 1.5m and a second on the top of the 40m tower near the Lutz weir. ETgages are read at approximately the same time of day and with the same frequency and the rain gauges on BCI.

The data from the ETgages are used to estimate the total water balance for the Lutz catchment. Water balance is calculated as: Rainfall - Weir run-off - Evapotranspiration.

The results from the ETgages and the estimated water balance (Precipitation - (Run Off + Evapotranspiration)) for the Lutz Tower for from Nov. 1993 to the end of 2002 are given on pages 30 and 31.

Daily Rainfall (mm) on BCI recorded at ~900 hrs

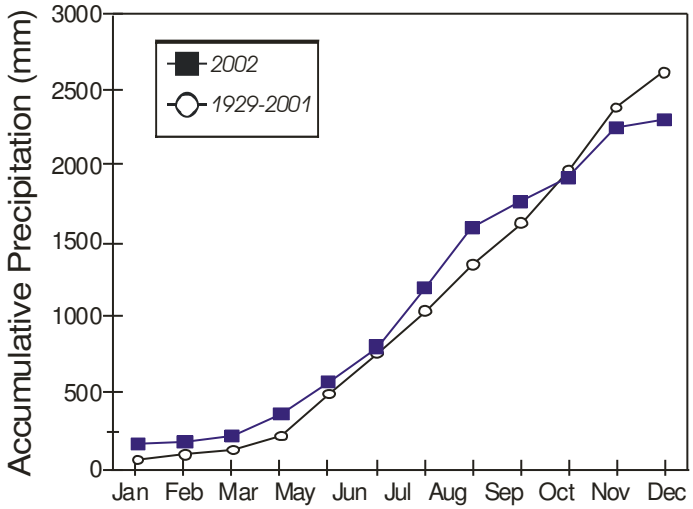
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	8.7	0.0	0.0	0.0	0.0	0.0	2.4	0.8	0.0	0.0	0.4	0.0
2	46.0	0.0	0.0	1.0	6.4	50.0	15.7	1.0	4.2	0.5	0.0	0.0
3	1.5	0.0	0.0	0.0	0.0	11.4	0.0	9.5	3.8	4.1	0.0	2.0
4	7.9	2.8	0.1	11.7	1.9	1.0	0.0	10.4	21.6	2.3	0.0	0.4
5	0.6	0.3	0.0	0.8	3.2	33.8	23.4	5.0	0.0	16.0	29.2	0.0
6	0.0	0.0	0.0	0.3	0.0	0.5	100.3	0.0	0.0	0.0	3.3	4.3
7	14.5	0.0	0.0	1.3	0.0	0.1	5.8	10.9	0.0	12.9	10.5	1.0
8	0.9	0.0	0.0	1.9	0.0	6.5	0.3	36.1	1.2	5.1	8.9	0.0
9	38.9	0.0	0.0	0.0	11.4	0.0	4.1	43.9	0.3	0.0	0.0	0.0
10	6.1	0.0	2.7	0.0	0.0	2.9	0.0	1.9	0.8	0.1	6.7	0.3
11	0.0	0.0	0.3	0.0	0.0	0.0	37.1	0.3	4.8	13.7	0.0	0.3
12	0.0	0.0	0.0	0.0	8.4	0.0	1.5	1.3	0.5	0.0	14.9	0.3
13	0.0	0.0	0.1	0.0	0.0	4.6	6.1	3.3	2.5	0.8	0.1	0.5
14	10.4	0.0	0.5	0.0	0.0	1.5	4.7	0.0	0.0	0.0	49.0	0.3
15	23.4	0.0	0.0	0.0	0.0	4.6	30.1	5.1	20.8	0.5	7.5	22.7
16	0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	8.6	0.0	5.3	14.6
17	0.0	0.0	0.0	39.6	17.0	4.6	3.6	0.0	20.8	0.0	18.9	0.0
18	0.0	0.8	0.0	36.8	5.5	30.2	1.8	0.0	0.0	1.8	19.8	0.0
19	0.0	5.8	0.0	0.0	0.3	0.0	0.3	0.8	0.3	17.5	19.1	0.0
20	0.0	0.0	4.1	0.0	0.0	0.0	34.1	44.7	0.0	8.0	0.5	0.0
21	0.0	0.3	0.0	0.0	0.3	0.3	3.7	1.0	0.0	26.8	4.3	4.3
22	0.0	0.0	0.0	0.0	54.4	9.3	0.0	0.0	0.0	8.9	7.4	0.0
23	0.0	0.0	37.8	0.0	13.6	0.3	1.0	48.0	26.2	3.8	32.6	0.0
24	0.0	0.0	0.0	1.4	0.3	45.0	6.4	2.3	32.3	1.3	72.5	0.0
25	0.0	0.3	0.0	0.8	0.0	0.0	10.4	2.0	0.1	11.7	9.7	0.0
26	0.0	0.0	0.0	1.0	18.3	0.0	40.6	3.5	9.9	0.3	0.5	0.0
27	0.0	0.0	0.0	0.0	67.8	1.3	3.8	64.3	8.1	1.4	1.0	0.0
28	0.0	0.0	0.1	0.0	0.0	1.8	9.1	86.9	0.0	5.0	0.0	0.0
29	0.1		0.0	44.5	6.6	2.4	34.1	0.0	0.0	0.8	1.5	2.0
30	0.0		0.8	0.0	0.0	16.1	1.0	5.6	5.1	3.0	0.8	0.0
31	0.0		0.0		0.0		13.2	8.2		11.2		0.0
	159.0	**10.2**	**46.6**	**141.1**	**215.3**	**228.1**	**396.8**	**396.8**	**172.0**	**157.4**	**324.4**	**53.0**

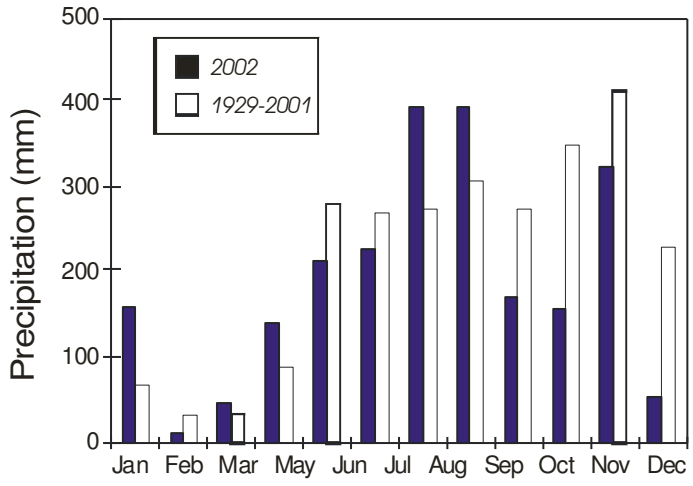


Monthly Rainfall at 'El Claro' - Rain Guage

Rainfall (mm)

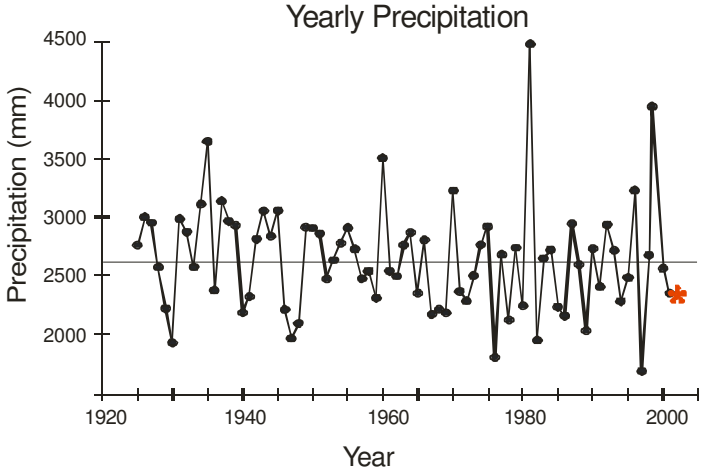
	Average	Min	Max	S.D.	2002	Rank (n=74)
January	70.3	0.0	374.0	76.5	**159.0**	**8**
February	32.2	0.5	186.4	34.5	**10.2**	**53**
March	33.6	0.0	173.7	36.7	**46.6**	**19**
April	92.9	0.0	463.8	88.0	**141.1**	**16**
May	277.2	78.5	622.0	101.4	**215.3**	**52**
June	270.8	66.8	541.0	88.5	**228.1**	**49**
July	273.1	92.0	725.9	96.8	**396.8**	**6**
August	308.8	149.6	586.0	92.4	**396.8**	**12**
September	273.1	130.8	507.0	85.3	**172.0**	**66**
October	348.6	153.9	544.0	93.0	**157.4**	**73**
November	409.3	110.0	1056.1	191.6	**324.4**	**47**
December	243.1	15.9	712.7	175.0	**53.0**	**63**
Total	**2633.1**	**1699.7**	**4465.0**	**462.1**	**2300.6**	**54**

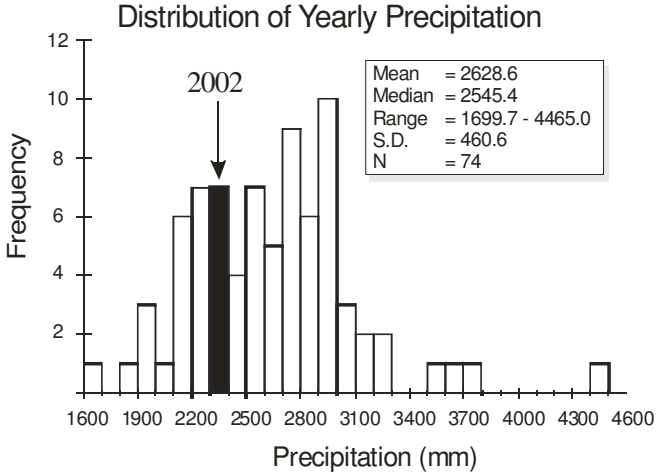




Yearly Rainfall (mm) at 'El Claro' - Rain Gauge

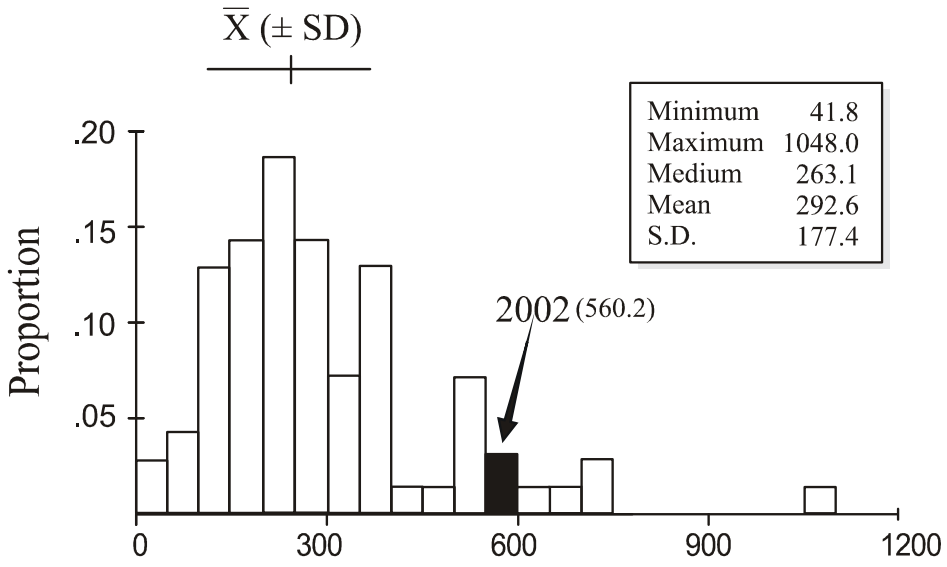
Year	Rain	Year	Rain	Year	Rain
1925	2764.0	1951	2863.8	1977	2685.0
1926	3003.0	1952	2481.6	1978	2132.0
1927	2956.1	1953	2637.5	1979	2742.0
1928	2579.1	1954	2684.3	1980	2252.0
1929	2228.3	1955	2910.3	1981	4465.0
1930	1940.6	1956	2729.7	1982	1960.0
1931	2981.5	1957	2482.1	1983	2654.0
1932	2878.6	1958	2545.1	1984	2726.0
1933	2581.9	1959	2317.0	1985	2242.0
1934	3109.5	1960	3500.4	1986	2167.6
1935	3642.6	1961	2545.6	1987	2955.2
1936	2384.3	1962	2373.4	1988	2602.9
1937	3117.6	1963	2767.1	1989	2176.2
1938	2969.0	1964	2875.3	1990	2767.5
1939	2932.9	1965	2357.1	1991	2642.4
1940	2195.8	1966	2807.7	1992	3047.5
1941	2332.2	1967	2181.4	1993	2729.2
1942	2816.9	1968	2223.5	1994	2285.2
1943	3055.4	1969	2192.5	1995	2531.1
1944	2838.7	1970	3141.2	1996	3227.8
1945	3058.9	1971	2373.6	1997	1699.7
1946	2221.0	1972	2292.0	1998	2683.8
1947	1978.2	1973	2506.0	1999	3726.1
1948	2105.7	1974	2770.0	2000	2550.2
1949	2916.2	1975	2923.0	2001	2331.2
1950	2908.3	1976	1818.0	**2002**	**2300.6**



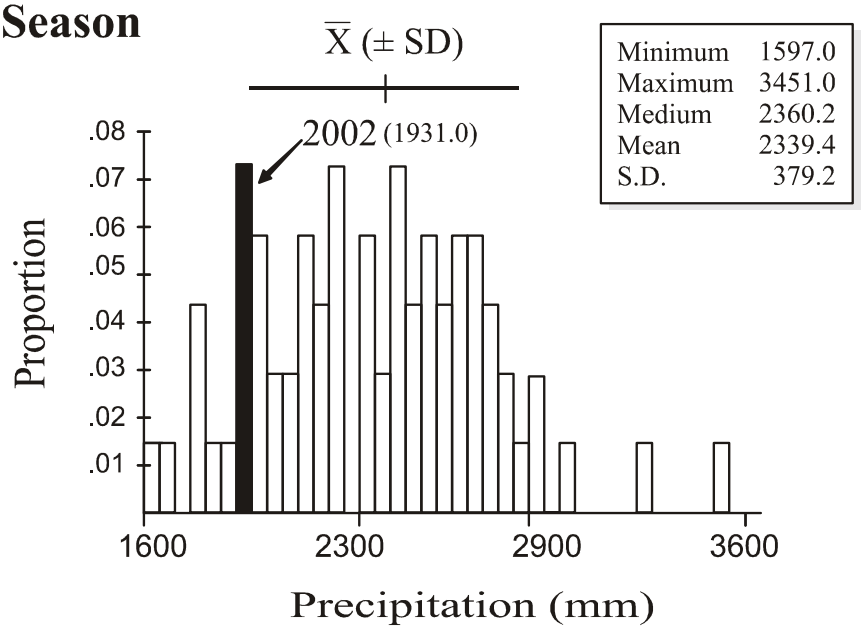


Seasonal Distribution of Precipitation

Dry Season



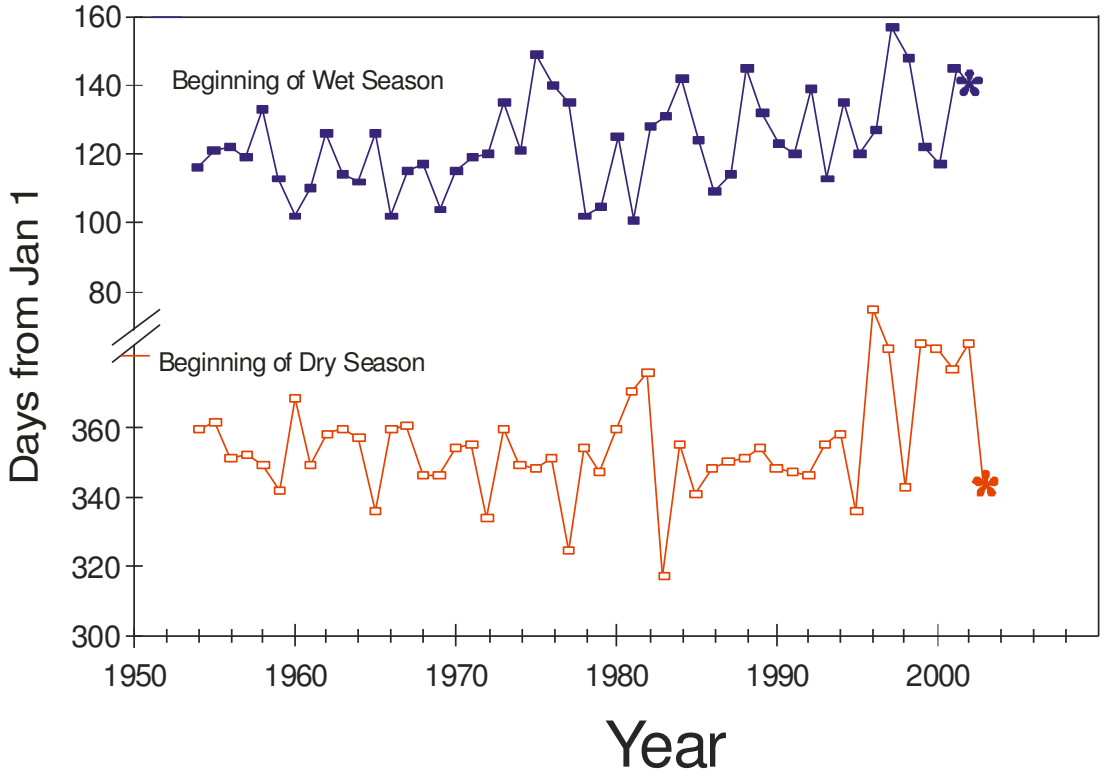
Wet Season



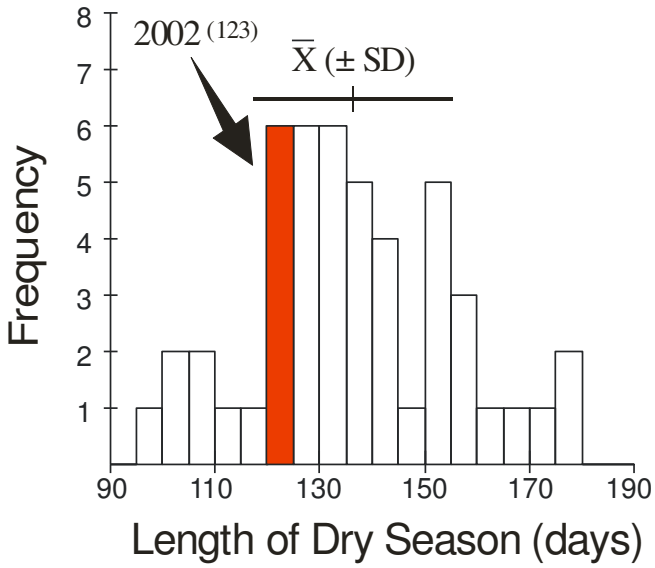
PCC Dry Season Beginning and End Dates

Year	Begin	End	Length		Year	Begin	End	Length	
			Dry Season	Wet Season				Dry Season	Wet Season
1954	25-Dec-1953	27-Apr-1954	123	244	1998	09-Dec-1997	29-May-1998	171	234
1955	27-Dec-1954	02-May-1955	126	229	1999	18-Jan-1999	3-May-1999	105	259
1956	17-Dec-1955	02-May-1956	137	229	2000	17-Jan-2000	27-Apr-2001	101	258
1957	17-Dec-1956	30-Apr-1957	134	229	2001	10-Jan-2001	26-May-2002	136	237
1958	15-Dec-1957	14-May-1958	150	208	**2002**	**18-Jan-2002**	**21-May-2002**	**123**	**201**
1959	08-Dec-1958	24-Apr-1959	137	254	**2003**	**08-Dec-2002**			
1960	03-Jan-1960	12-Apr-1960	100	246					
1961	14-Dec-1960	21-Apr-1961	128	247					
1962	24-Dec-1961	07-May-1962	134	232					
1963	25-Dec-1962	25-Apr-1963	121	243					
1964	24-Dec-1963	22-Apr-1964	120	223					
1965	01-Dec-1964	07-May-1965	157	232					
1966	25-Dec-1965	13-Apr-1966	109	257					
1967	26-Dec-1966	26-Apr-1967	121	230					
1968	12-Dec-1967	27-Apr-1968	137	228					
1969	11-Dec-1968	15-Apr-1969	125	249					
1970	20-Dec-1969	26-Apr-1970	127	239					
1971	21-Dec-1970	30-Apr-1972	130	214					
1972	30-Nov-1972	30-Apr-1972	152	238					
1973	24-Dec-1972	16-May-1973	143	213					
1974	15-Dec-1973	02-May-1974	138	226					
1975	14-Dec-1974	30-May-1975	167	201					
1976	17-Dec-1975	20-May-1976	155	184					
1977	20-Nov-1976	16-May-1977	177	218					
1978	20-Dec-1977	13-Apr-1978	114	244					
1979	13-Dec-1978	16-Apr-1979	124	253					
1980	25-Dec-1979	05-May-1980	132	244					
1981	04-Jan-1981	12-Apr-1981	98	273					
1982	10-Jan-1982	09-May-1982	119	189					
1983	14-Nov-1982	12-May-1983	179	223					
1984	21-Dec-1983	22-May-1984	153	198					
1985	06-Dec-1984	05-May-1985	150	223					
1986	14-Dec-1985	20-Apr-1986	127	240					
1987	16-Dec-1986	25-Apr-1987	130	236					
1988	17-Dec-1987	25-May-1988	160	208					
1989	19-Dec-1988	13-May-1989	145	215					
1990	14-Dec-1989	04-May-1990	141	223					
1991	13-Dec-1990	01-May-1991	139	225					
1992	12-Dec-1991	19-May-1992	159	215					
1993	20-Dec-1992	24-Apr-1993	125	244					
1994	24-Dec-1993	16-May-1994	143	200					
1995	02-Dec-1994	01-May-1995	150	272					
1996	27-Jan-1996	07-May-1996	101	255					
1997	17-Jan-1997	07-Jun-1997	141	185					
					Avg	**20-Dec**	**02-May**	**135.2**	**229.8**
					SD	**±15 days**	**±14 days**	**19.9**	**21.0**

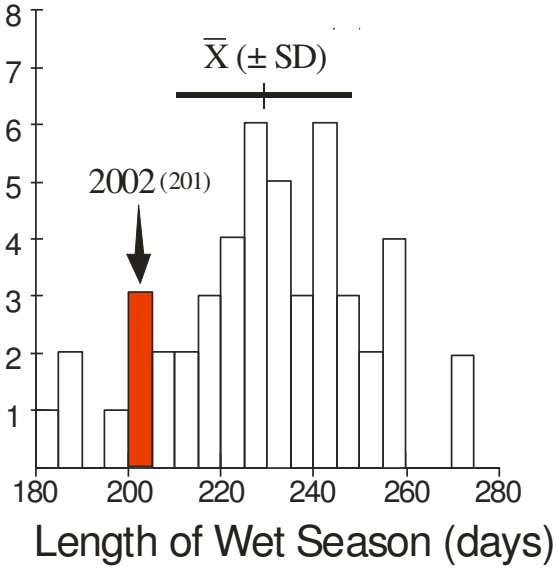
Seasonality Distribution



Minimum	98
Maximum	179
Medium	134.0
Mean	135.0
S.D.	19.6



Minimum	184
Maximum	273
Medium	230.0
Mean	229.9
S.D.	21.2

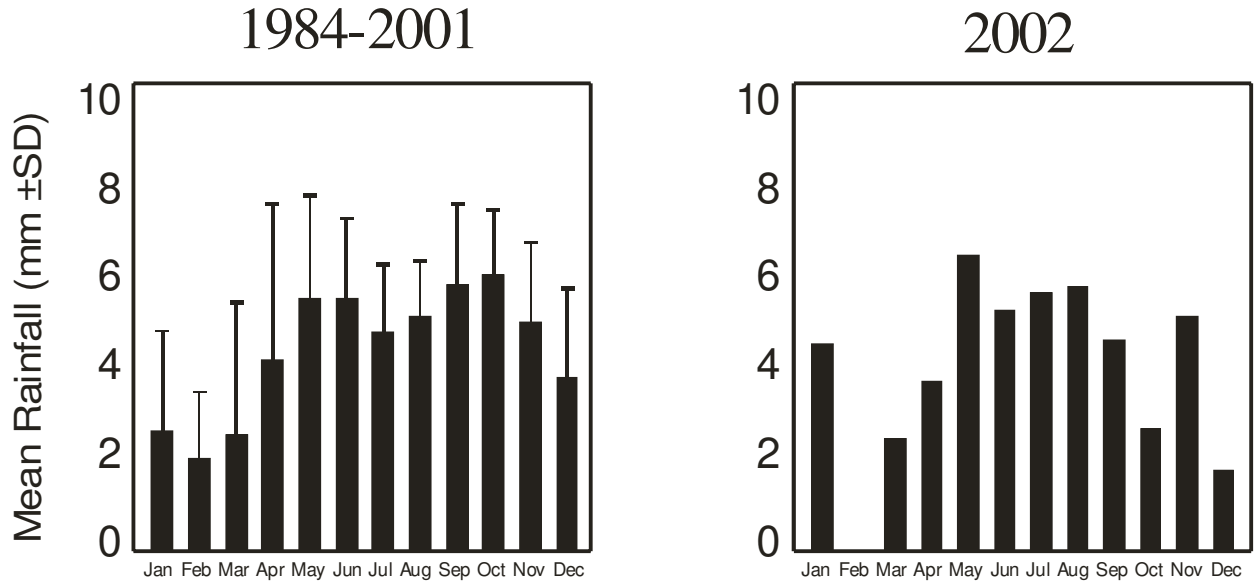


Storm Analysis

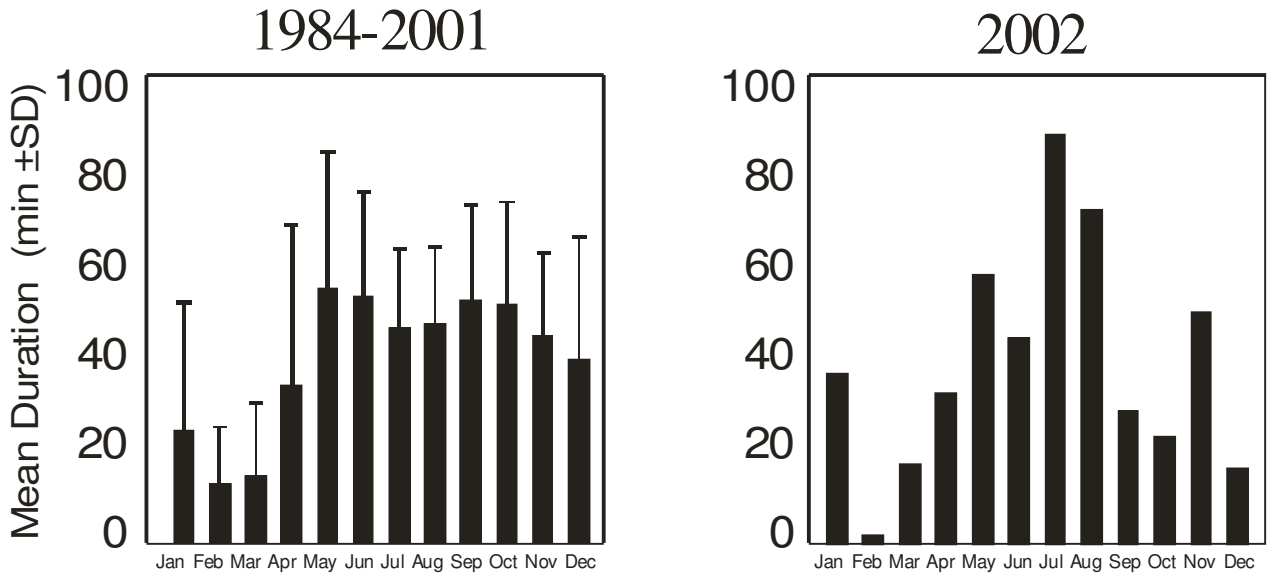
	Max. Rainfall per Storm (mm)			Storm Duration (min.)		
	1984-2001		2002	1984-2001		2002
	Mean	S.D.		Mean	S.D.	
January	24.1	27.2	**36.1**	31.4	17.9	**45.0**
February	12.6	12.2	**2.0**	29.0	25.7	**21.7**
March	14.3	15.6	**17.0**	40.1	42.4	**46.9**
April	33.7	34.3	**32.0**	45.8	38.0	**57.7**
May	54.5	28.9	**57.2**	55.5	14.9	**60.9**
June	52.6	22.5	**43.7**	55.9	8.6	**34.9**
July	46.0	17.0	**86.6**	48.2	9.0	**33.5**
August	47.0	16.3	**70.9**	47.1	10.5	**54.0**
September	52.0	20.1	**28.2**	56.9	11.1	**40.2**
October	51.1	21.6	**22.9**	57.9	12.0	**35.5**
November	44.2	17.7	**49.0**	53.2	18.8	**52.0**
December	39.4	25.9	**16.3**	40.8	21.7	**28.7**

	Av. Rainfall per Storm (mm)		
	1984-2001		2002
	Mean	S.D.	
January	2.6	2.1	**4.4**
February	2.0	1.4	**0.8**
March	2.5	2.8	**2.4**
April	4.1	3.3	**3.6**
May	5.4	2.2	**6.3**
June	5.4	1.7	**5.1**
July	4.7	1.4	**5.5**
August	5.0	1.2	**5.6**
September	5.7	1.7	**4.5**
October	5.9	1.4	**2.6**
November	4.9	1.7	**5.0**
December	3.7	1.9	**1.7**

Average Monthly Storm Size

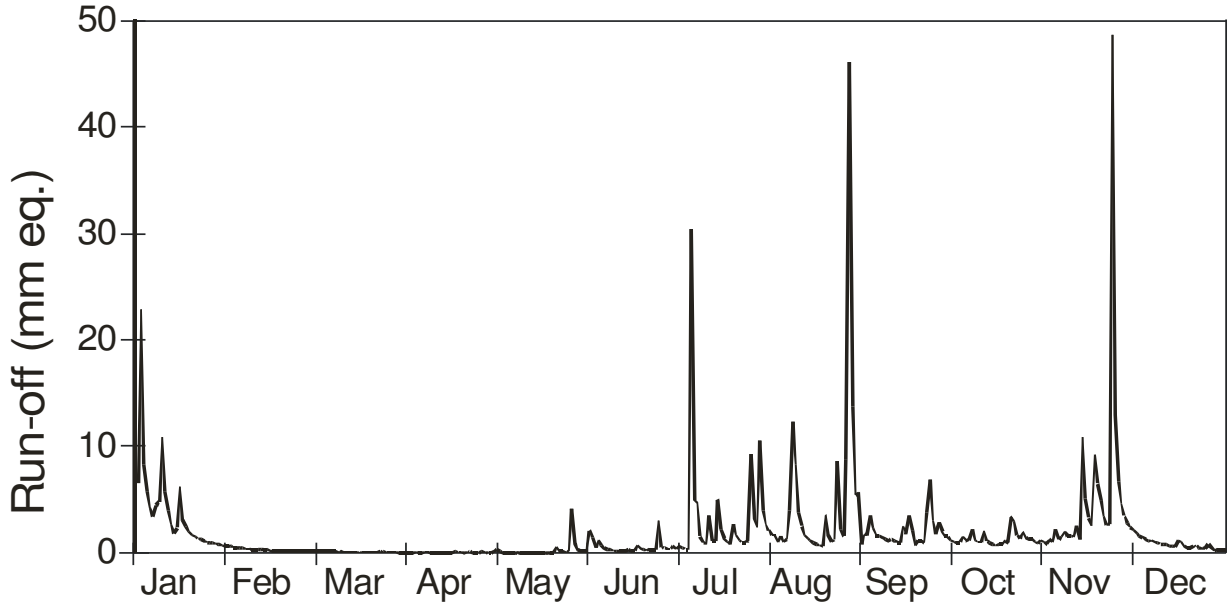


Average Monthly Storm Duration



Daily Lutz Weir Run-off (mm .eq.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	6.5	0.6	0.1	0.0	0.3	2.1	0.6	1.7	1.8	1.0	0.8	1.8
2	22.8	0.5	0.1	0.0	0.1	1.4	0.5	1.7	1.7	1.0	1.3	1.6
3	8.2	0.5	0.1	0.0	0.0	0.4	0.4	1.0	3.5	1.0	1.0	1.5
4	5.8	0.5	0.1	0.1	0.0	1.1	0.3	1.6	2.3	1.5	2.3	1.3
5	4.2	0.4	0.1	0.0	0.0	0.8	30.3	1.0	1.6	1.2	1.3	1.1
6	3.4	0.4	0.1	0.0	0.0	0.4	5.0	1.3	1.6	1.2	1.6	1.2
7	4.5	0.4	0.1	0.1	0.0	0.3	4.7	3.9	1.5	2.2	2.0	1.0
8	4.8	0.4	0.1	0.0	0.0	0.3	1.5	12.3	1.3	1.2	1.6	0.9
9	10.9	0.3	0.1	0.0	0.0	0.2	0.9	8.3	1.1	1.0	1.6	0.8
10	5.8	0.3	0.1	0.0	0.0	0.2	0.8	3.8	1.2	1.0	1.5	0.8
11	3.9	0.3	0.1	0.0	0.0	0.2	3.5	2.5	1.1	2.1	2.6	0.7
12	2.7	0.3	0.1	0.0	0.0	0.1	1.1	1.7	1.0	1.1	1.3	0.7
13	1.9	0.2	0.1	0.0	0.0	0.2	1.1	1.4	0.9	0.9	10.8	0.7
14	2.3	0.2	0.1	0.0	0.0	0.3	5.0	1.2	2.4	0.8	5.1	0.6
15	6.2	0.2	0.1	0.0	0.0	0.1	2.3	1.0	1.8	0.7	3.3	1.2
16	3.1	0.2	0.1	0.0	0.0	0.2	1.3	0.8	3.5	0.7	2.5	1.0
17	2.4	0.2	0.1	0.1	0.0	0.7	1.1	0.7	2.1	0.8	9.2	0.6
18	1.9	0.2	0.1	0.1	0.0	0.4	0.8	0.6	0.7	1.1	6.5	0.5
19	1.7	0.2	0.1	0.1	0.0	0.3	2.7	3.6	1.1	1.0	5.0	0.5
20	1.5	0.2	0.1	0.0	0.0	0.2	1.7	1.6	1.1	3.4	3.4	0.6
21	1.3	0.2	0.1	0.1	0.6	0.3	1.2	1.1	1.0	2.9	2.6	0.7
22	1.2	0.2	0.1	0.1	0.1	0.3	1.0	1.2	3.8	1.7	2.7	0.5
23	1.1	0.2	0.2	0.0	0.1	0.2	1.0	8.6	6.8	1.4	48.5	0.4
24	1.0	0.1	0.1	0.0	0.1	3.1	1.1	2.2	3.0	1.9	12.9	0.4
25	1.0	0.1	0.1	0.0	0.1	0.6	9.2	1.6	1.8	1.4	6.7	0.8
26	0.9	0.1	0.1	0.2	4.2	0.4	3.2	8.7	2.9	1.3	4.6	
27	0.9	0.1	0.1	0.1	0.8	0.4	2.4	45.9	2.0	1.3	3.5	0.2
28	0.8	0.1	0.1	0.0	0.3	0.4	10.6	13.8	1.6	1.0	2.8	0.3
29	0.7		0.0	0.0	0.2	0.6	3.9	5.4	1.5	0.9	2.4	0.3
30	0.6		0.0	0.1	0.1	0.4	2.7	5.7	1.2	1.2	2.1	0.3
31	0.6		0.0		0.1		2.1	0.8		1.0		0.3



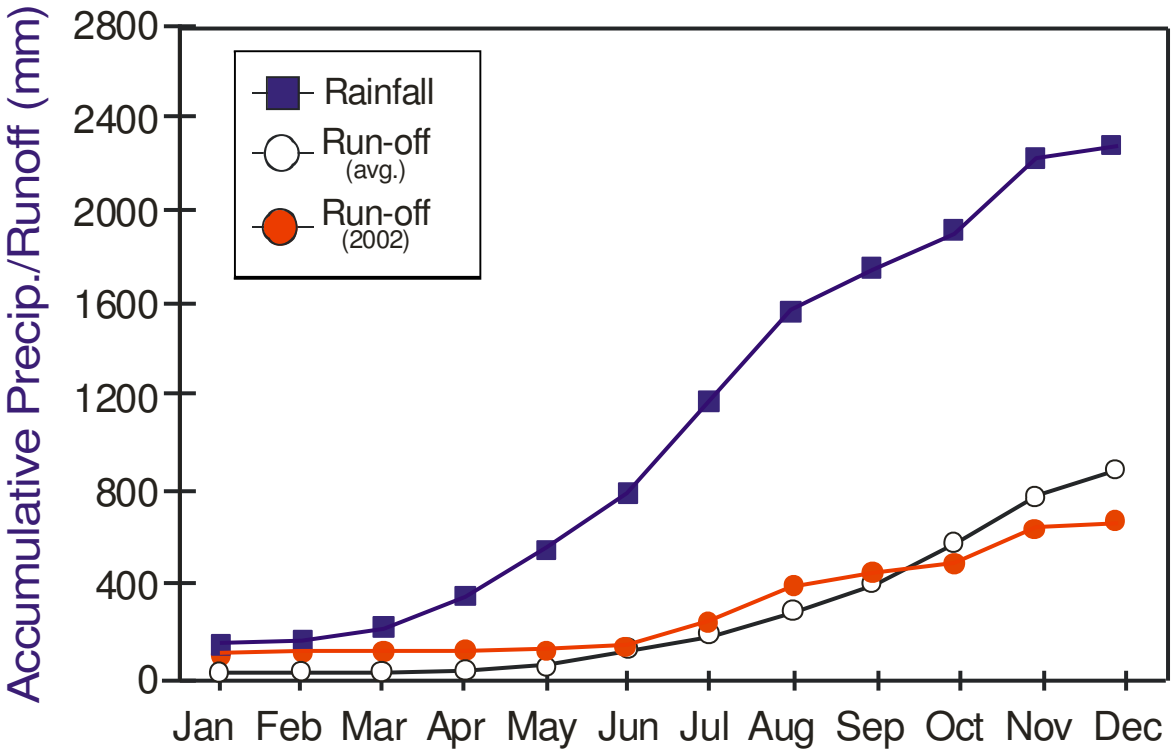
Monthly Run-off at Lutz Weir

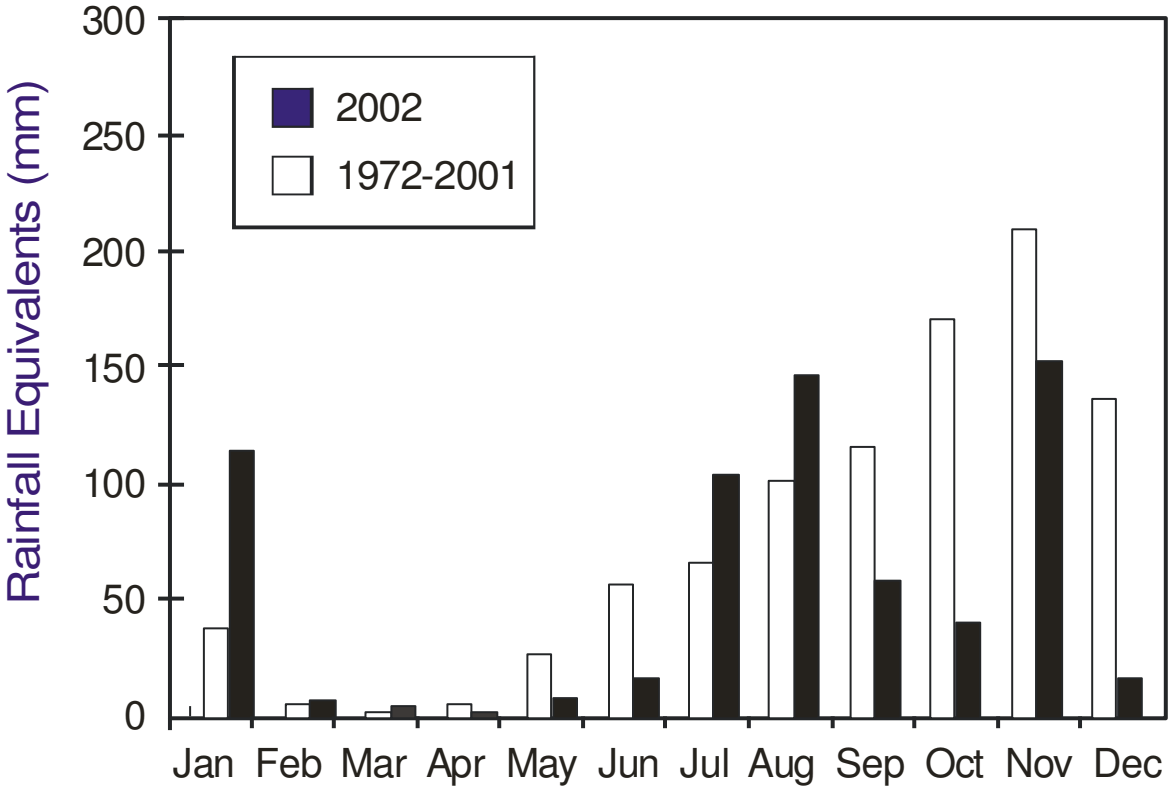
Run-off (mm eq.)

	Long-term Averages (1972 - 2001)				
	Peak	Delayed	Base	Total	S.D.
January	13.3	2.0	22.7	**38.0**	63.1
February	0.2	0.3	5.1	**5.6**	10.5
March	0.1	0.2	1.5	**1.8**	2.6
April	3.4	0.6	1.9	**5.9**	20.6
May	12.6	3.7	10.3	**26.6**	44.1
June	26.5	5.6	24.5	**56.6**	74.0
July	22.7	6.5	37.0	**66.1**	53.0
August	40.3	8.0	52.7	**101.0**	77.3
September	44.9	9.0	62.0	**115.9**	69.8
October	69.2	10.4	91.5	**171.2**	85.2
November	81.8	11.5	116.8	**210.0**	108.8
December	48.6	6.7	81.4	**136.7**	118.5
Total	364.7	62.9	511.9	**941.6**	445.4

	2002			
	Peak	Delayed	Base	Total
January	22.1	7.2	85.4	114.7
February	0.0	0.0	7.6	7.6
March	0.0	0.1	4.6	4.8
April	0.0	0.3	1.3	1.6
May	4.0	1.4	2.3	7.8
June	4.0	3.2	8.2	15.4
July	44.1	10.0	50.0	104.1
August	66.7	10.3	69.8	146.8
September	12.9	6.3	39.6	58.9
October	4.7	3.7	32.4	40.8
November	61.9	13.7	77.7	153.4
December	0.3	0.8	15.7	16.7
Total	**220.8**	**57.1**	**394.7**	**672.6**

Monthly run-off at Lutz Weir

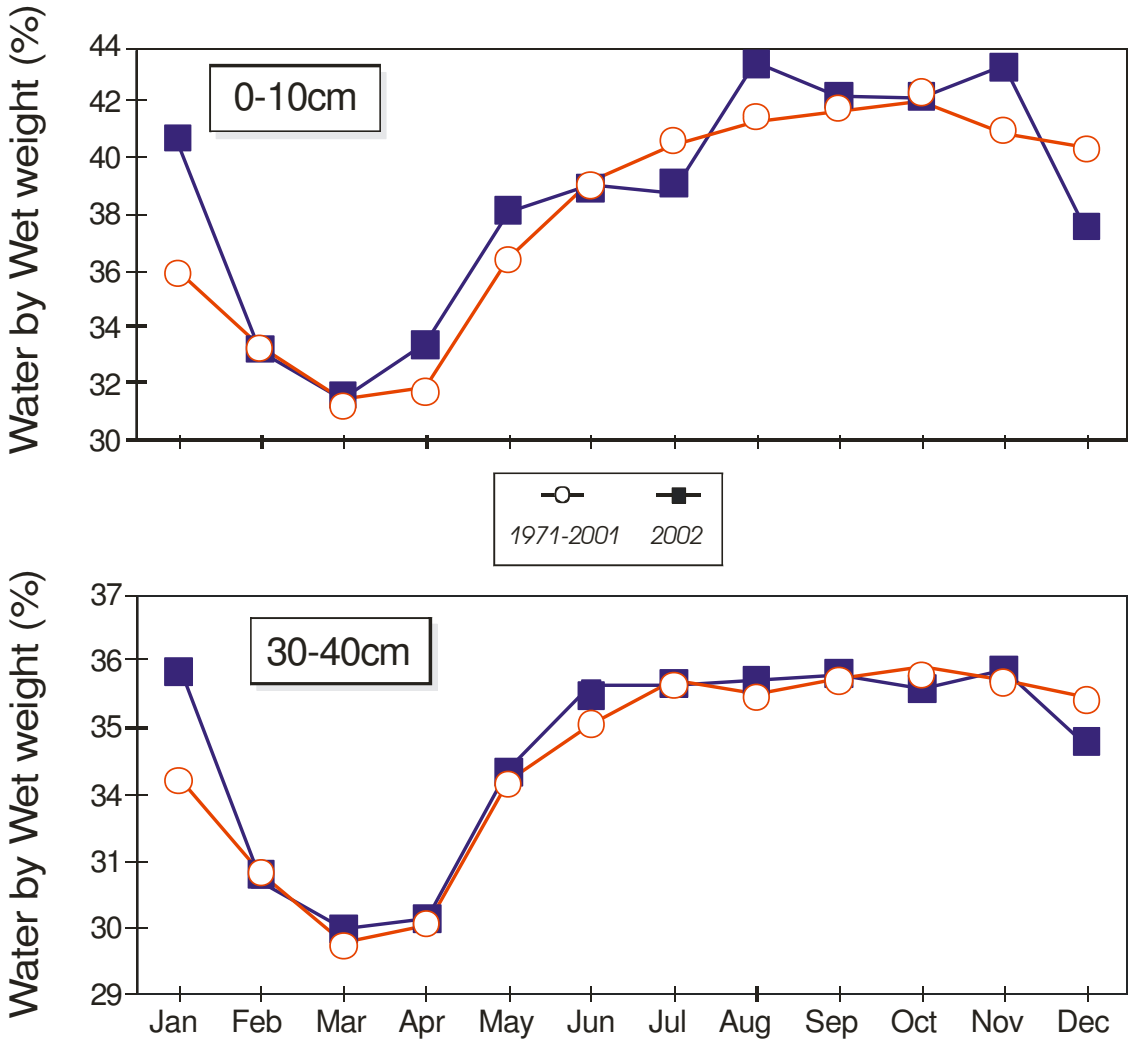




Lutz Catchment Soil Moisture

(H_2O/wet wt of soil)

	Long-term Averages (1972-2001)				2002	
	0-10 cm		30-40 cm		0-10 cm	30-40 cm
	Mean	S.D.	Mean	S.D.		
January	36.2	3.2	33.3	2.7	40.8	35.6
February	33.4	2.4	31.4	1.4	33.2	31.2
March	31.5	2.2	30.0	1.3	31.5	30.3
April	31.9	2.5	30.3	1.7	33.5	30.5
May	36.6	2.3	33.3	1.4	38.2	33.5
June	39.3	1.7	34.4	1.0	39.3	35.2
July	40.6	1.4	35.3	1.3	38.9	35.2
August	41.5	1.8	35.0	0.7	43.6	35.3
September	41.8	1.5	35.3	1.0	42.4	35.4
October	42.2	1.7	35.6	0.8	42.3	35.1
November	41.0	8.2	35.3	1.2	43.5	35.3
December	40.5	2.9	34.9	1.8	37.6	34.0



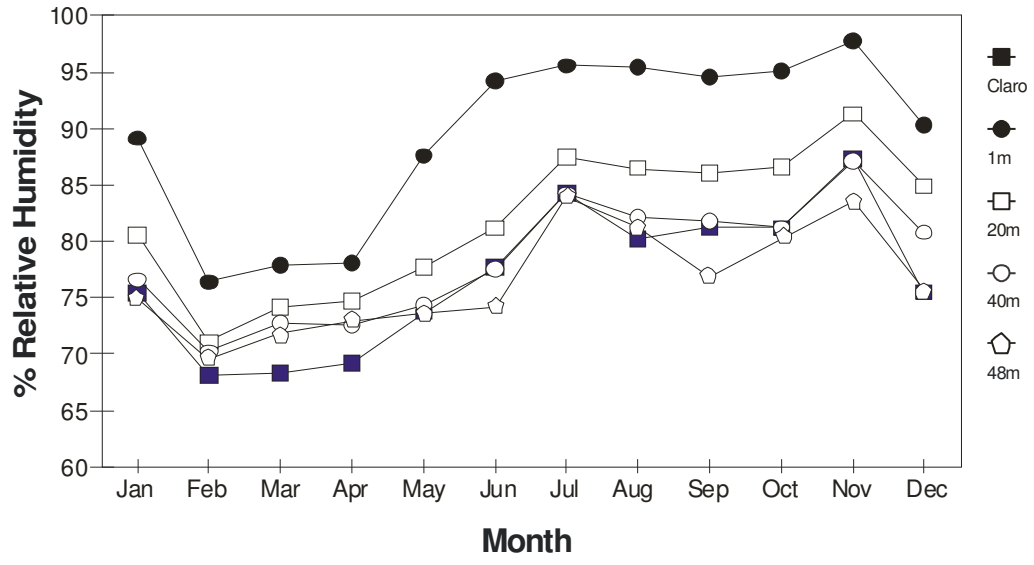
Relative Humidity (%)

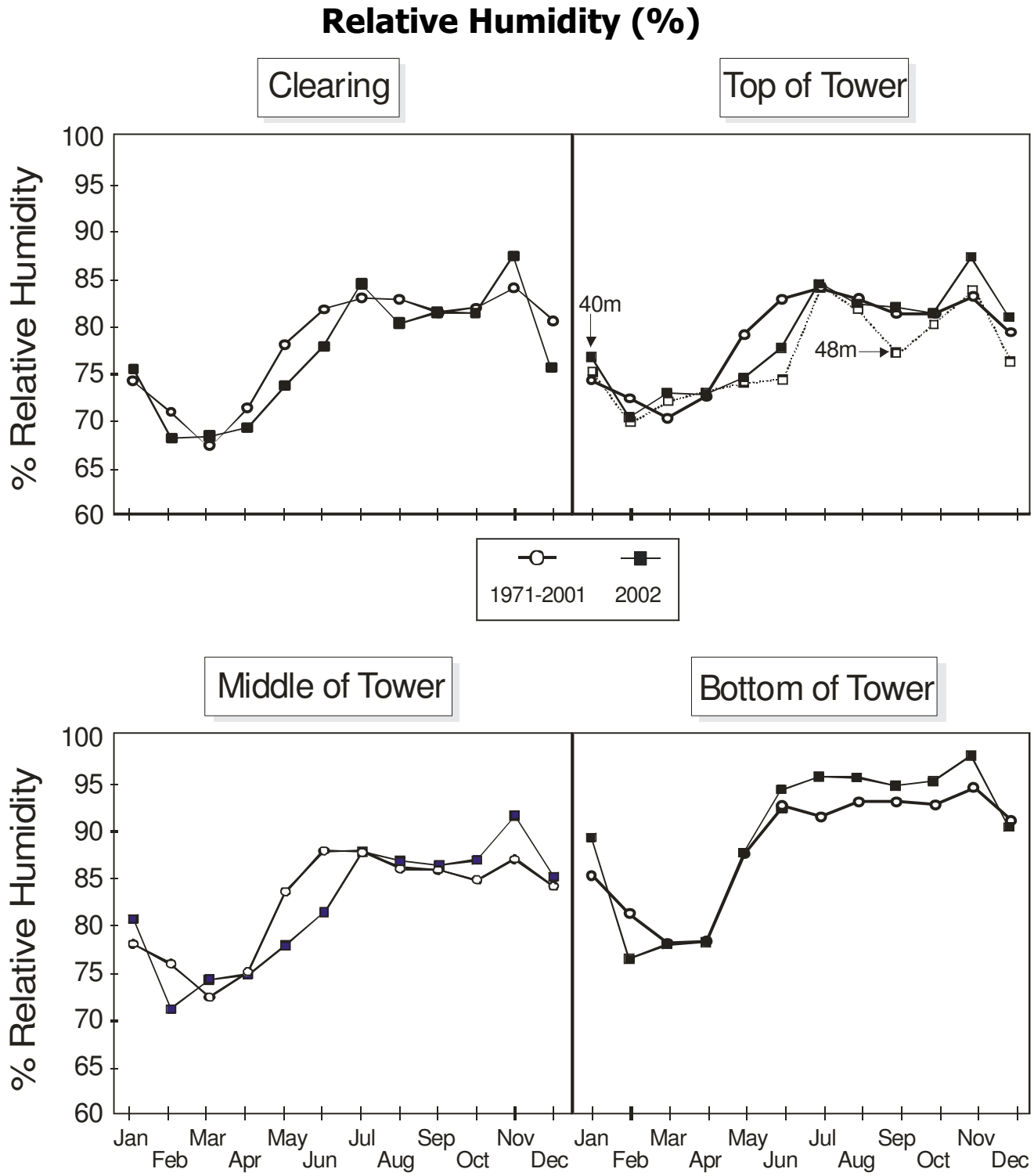
Long-term Averages (1972-2001)

	'El Claro'		1m		20m		40m		48m	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
January	74.2	4.5	85.6	3.6	77.9	4.1	74.6	3.6	-	-
February	70.9	4.0	81.2	3.8	75.8	3.8	72.4	4.1	-	-
March	67.4	3.8	78.3	3.9	72.4	3.2	70.7	2.8	-	-
April	71.2	4.9	78.6	5.1	74.9	3.5	72.6	2.8	-	-
May	77.9	4.8	87.6	4.0	83.4	2.9	79.0	3.7	-	-
June	81.6	4.2	92.8	2.7	87.5	2.9	82.8	3.2	-	-
July	82.7	4.4	91.9	6.4	87.6	3.2	84.0	3.3	-	-
August	82.7	4.5	93.0	2.7	85.7	2.7	82.8	2.6	-	-
September	81.2	4.7	93.1	1.7	85.7	2.3	81.1	3.2	-	-
October	81.9	4.0	92.5	5.4	84.5	3.4	80.8	3.4	-	-
November	83.8	3.9	94.2	2.5	86.8	3.8	83.1	4.1	-	-
December	80.4	5.1	91.1	3.6	83.9	7.5	80.1	4.9	-	-

2002

	'El Claro'	1m	20m	40m	48m
January	**75.4**	**89.2**	**80.5**	**76.6**	**74.9**
February	**68.1**	**76.4**	**71.1**	**70.2**	**69.5**
March	**68.3**	**77.9**	**74.2**	**72.8**	**71.8**
April	**69.2**	**78.1**	**74.7**	**72.6**	**72.9**
May	**73.6**	**87.6**	**77.7**	**74.4**	**73.7**
June	**77.7**	**94.2**	**81.2**	**77.5**	**74.2**
July	**84.3**	**95.6**	**87.5**	**84.3**	**84.0**
August	**80.2**	**95.5**	**86.5**	**82.2**	**81.2**
September	**81.3**	**94.6**	**86.1**	**81.8**	**76.8**
October	**81.2**	**95.1**	**86.6**	**81.2**	**80.2**
November	**87.3**	**97.8**	**91.3**	**87.1**	**83.6**
December	**75.5**	**90.3**	**84.9**	**80.8**	**75.7**



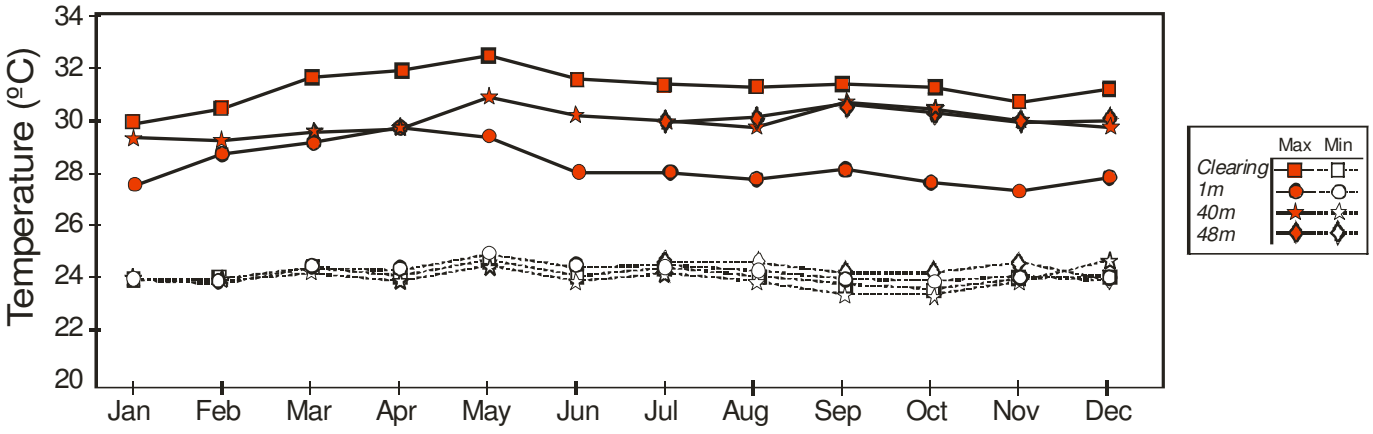

Relative Humidity (%)
Clearing
Top of Tower
Middle of Tower
Bottom of Tower
% Relative Humidity
100
95
90
85
80
75
70
65
60
40m
48m
1971-2001
2002
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

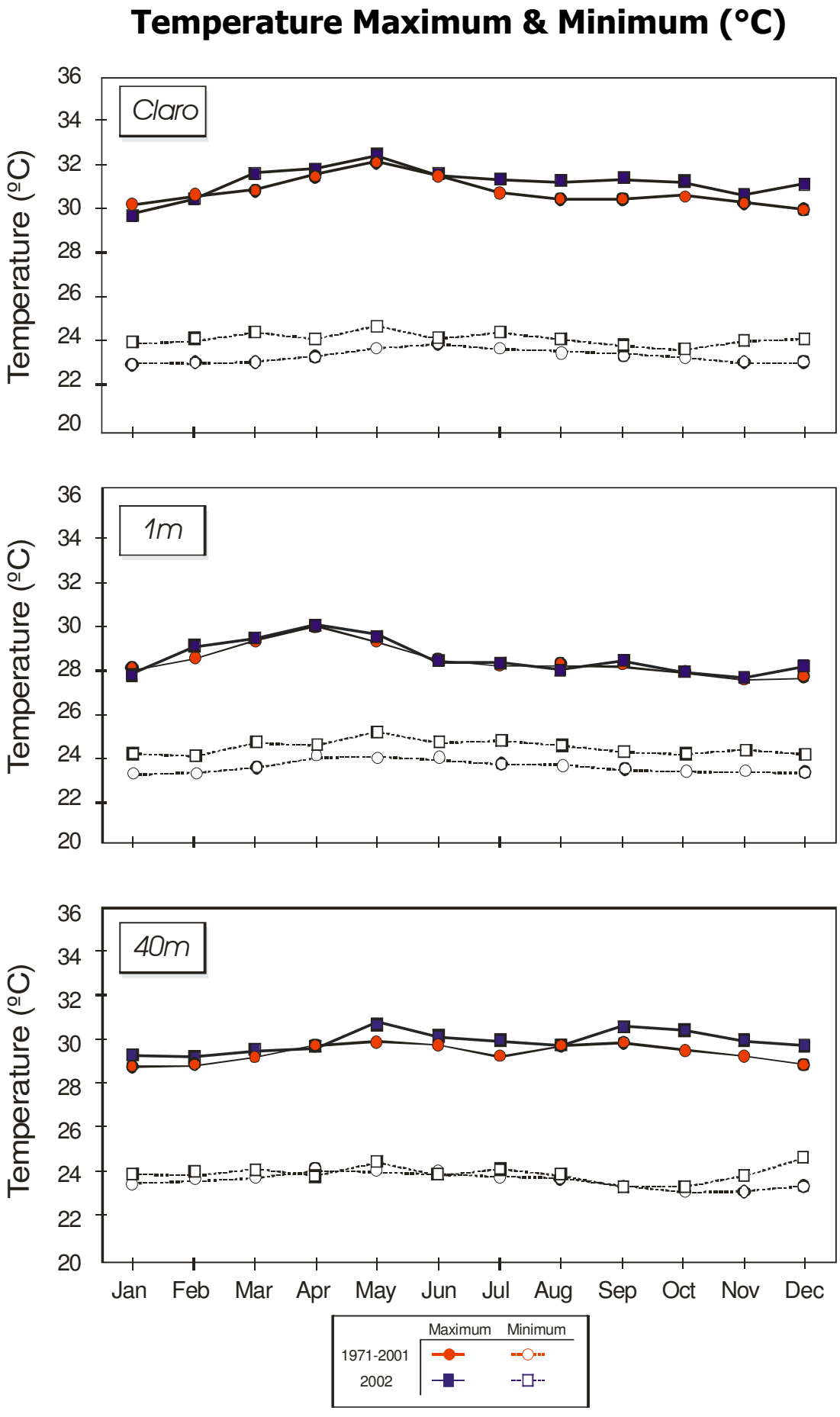
Avg. Monthly Maximum & Minimum (°C) Temperatures

Long-term Averages (1972-2001)

	'El Claro'		1m		20m		40m		48m	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	30.6	23.1	27.6	23.0	28.9	23.6	30.6	23.1	-	-
February	30.9	23.2	28.2	23.2	28.9	23.7	30.9	23.2	-	-
March	31.6	23.4	29.0	23.4	29.2	23.8	31.6	23.4	-	-
April	32.2	23.9	29.7	23.8	29.8	24.2	32.2	23.9	-	-
May	31.6	24.0	29.0	23.9	30.0	24.1	31.6	24.0	-	-
June	30.8	23.8	28.2	23.7	29.9	24.0	30.8	23.8	-	-
July	30.5	23.7	27.9	23.6	29.4	23.9	30.5	23.7	-	-
August	30.5	23.6	27.9	23.6	29.8	23.9	30.5	23.6	-	-
September	30.7	23.4	27.9	23.3	29.9	23.5	30.7	23.4	-	-
October	30.5	23.2	27.6	23.2	29.7	23.3	30.5	23.2	-	-
November	30.0	23.2	27.3	23.1	29.3	23.3	30.0	23.2	-	-
December	30.1	23.2	27.2	23.1	28.9	23.5	30.1	23.2	-	-

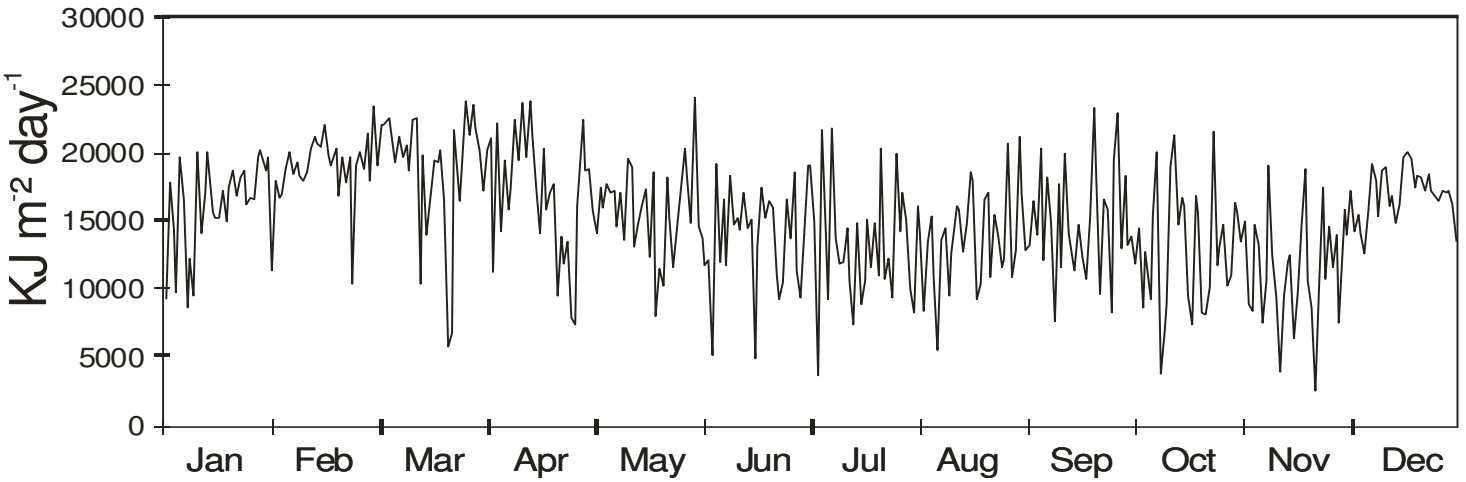
2002	'El Claro'		1m		40m		48m	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
January	29.9	24.0	27.6	24.0	29.4	24.1		
February	30.5	24.1	28.8	23.9	29.3	24.0		
March	31.7	24.5	29.2	24.5	29.6	24.3		
April	31.9	24.2	29.8	24.4	29.7	24.0		
May	32.5	24.8	29.4	25.0	30.9	24.6		
June	31.6	24.2	28.1	24.5	30.2	24.0		
July	31.4	24.5	28.1	24.6	30.0	24.3	29.9	24.7
August	31.3	24.2	27.8	24.4	29.8	24.0	30.1	24.7
September	31.4	23.9	28.2	24.1	30.7	23.5	30.6	24.3
October	31.3	23.7	27.7	24.0	30.5	23.5	30.3	24.3
November	30.7	24.1	27.4	24.2	30.0	24.0	29.9	24.7
December	31.2	24.2	27.9	24.0	29.8	24.8	30.0	24.0




Temperature Maximum & Minimum (°C)
Claro
1m
40m
Temperature (ºC)
36
34
32
30
28
26
24
22
20
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Maximum
Minimum
1971-2001
2002

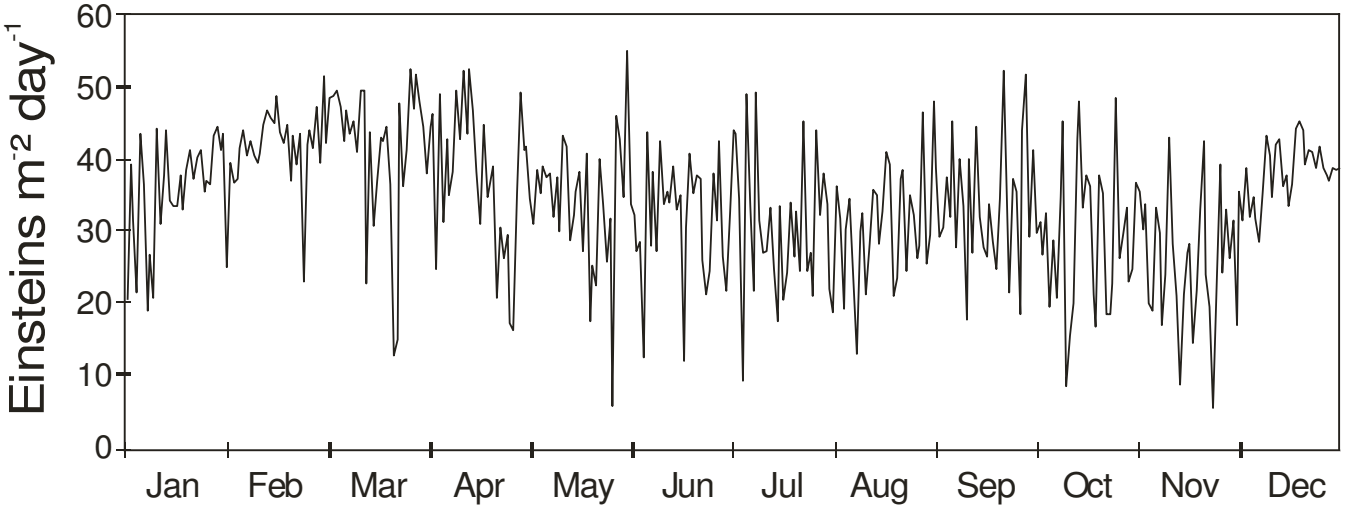
Daily Total Radiation (KJ m^{-2} day^{-1})

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	9368	18063	23486	17305	18967	14683	14355	8309	17069	13314	15843	15889
2	17951	16729	19220	20242	15769	13878	19218	16216	12946	13991	13565	14132
3	14425	17034	22135	21096	14147	11841	19167	14217	13306	12016	15098	17251
4	9831	18891	22173	11298	17565	12241	15011	8487	16593	14503	8970	14356
5	19816	20099	22578	22271	16064	5201	3810	13554	14089	8735	8494	15502
6	16637	18496	21549	14259	17779	19272	21813	15486	20353	12840	14818	14240
7	8744	19345	19420	19518	17110	12100	14344	10913	12151	9362	13279	12720
8	12271	18477	21259	15954	17295	16671	9334	5610	18329	15469	7615	15686
9	9583	17967	19818	17404	14670	11821	21874	13675	14960	20171	10701	19229
10	20141	18608	20631	22527	17152	18382	13802	14626	7736	3894	19142	18060
11	14175	20382	18731	19536	13687	14754	12005	9548	17765	6973	12646	15485
12	17163	21273	22509	23777	19713	15347	12026	12694	11681	8947	9477	18729
13	20082	20803	22584	19795	18988	14428	14579	16198	19990	19033	4001	19009
14	15671	20512	10422	23892	13191	17204	10689	15915	14209	21433	9564	16142
15	15351	22156	19900	21325	14768	14524	7551	12843	12272	14837	12109	16860
16	15280	19951	14063	17509	16185	15134	14948	14885	11472	16820	12581	14988
17	17251	19202	16860	14172	17444	4947	8977	18619	14796	16188	6529	16333
18	15114	20358	19561	20358	12478	13211	10669	18070	12476	9561	9802	19725
19	17514	16903	19342	15895	18630	17578	15185	9330	10852	7535	14780	20160
20	18755	19726	20291	17114	8099	15307	11717	10469	15332	16880	18974	19643
21	16967	17854	16700	17810	11591	16490	14878	16694	23400	15717	10708	17490
22	18337	19767	5902	9583	10347	15987	11128	17188	18352	8357	8713	18352
23	18791	10493	6905	13979	18253	11030	20410	10942	9692	8289	2611	18321
24	16253	19110	21719	12013	15369	9343	10836	15497	16674	10235	10571	17331
25	16823	20105	16578	13504	11749	10551	12276	13987	15883	21586	17492	18570
26	16614	18885	18793	7973	14516	16673	9459	11748	8341	11792	10896	17241
27	19745	21553	23889	7436		13856	19969	12335	19556	13216	14721	16889
28	20259	18037	21436	16118	20351	18659	14299	20759	22990	14857	11736	16500
29	18781		23572	22463	18454	11443	17134	10966	13108	10295	14053	17314
30	19809		21830	18834	14877	9471	15215	12924	18383	11043	7617	17165
31	11506		20326		24075		10120	21295		16415		17234



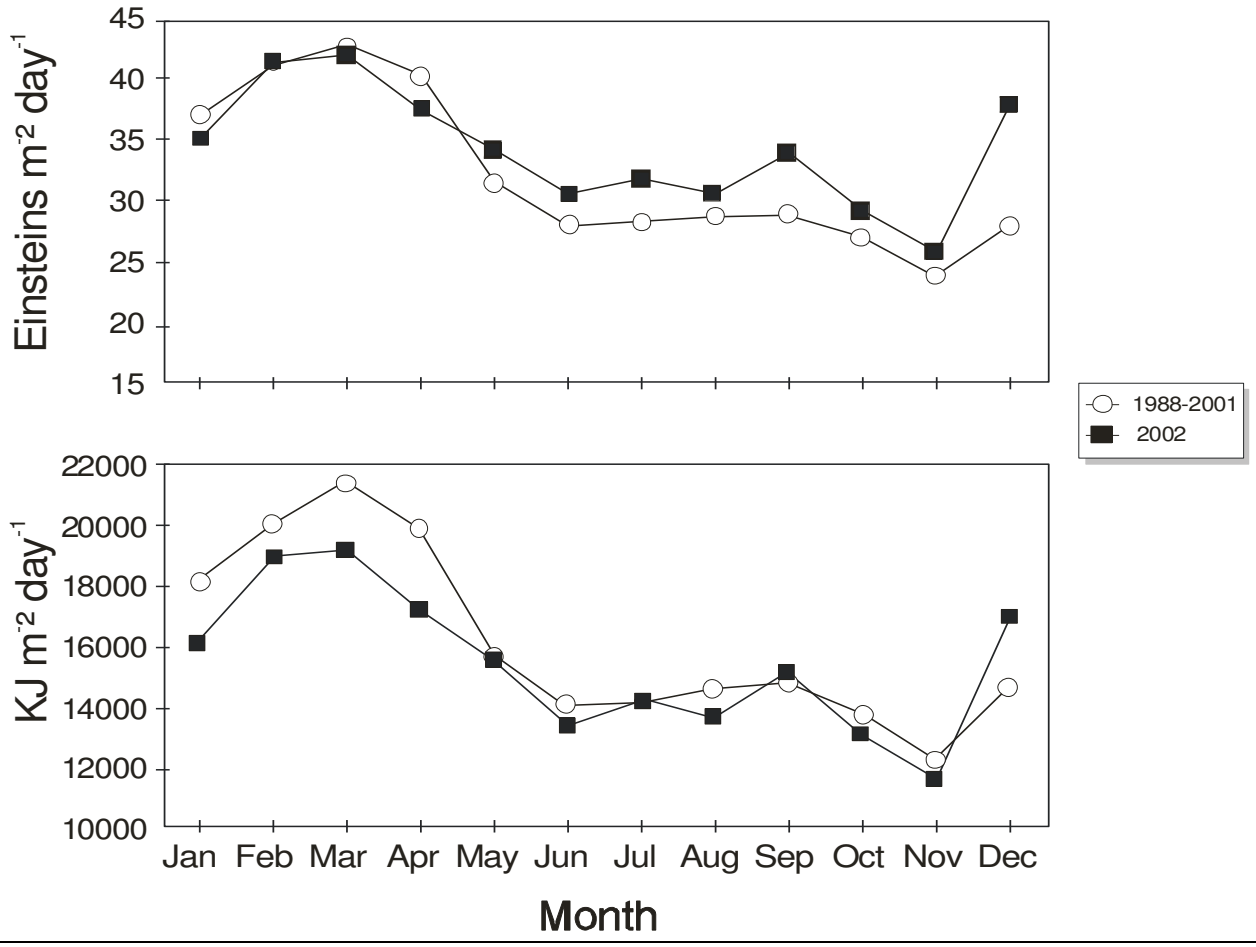
Daily Total PAR (Einsteins m^{-2} day^{-1})

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	20.6	39.7	51.6	38.0	41.7	33.9	33.0	19.0	38.9	29.9	35.6	35.7
2	39.5	36.8	42.2	44.5	34.7	32.3	44.1	36.2	29.3	31.4	30.5	31.8
3	31.7	37.4	48.7	46.4	31.1	27.5	43.6	31.9	30.7	27.0	33.9	38.8
4	21.6	41.5	48.7	24.8	38.6	28.7	34.7	19.3	37.7	32.6	20.2	32.3
5	43.6	44.2	49.6	49.0	35.3	12.8	9.4	30.3	32.0	19.6	19.1	34.8
6	36.6	40.7	47.4	31.3	39.1	43.9	49.1	34.7	45.3	28.9	33.3	32.0
7	19.2	42.5	42.7	42.9	37.6	28.1	33.6	24.5	27.8	21.0	29.8	28.6
8	27.0	40.6	46.7	35.1	38.0	38.5	21.9	13.2	40.2	34.8	17.1	35.3
9	21.1	39.5	43.6	38.3	32.2	27.4	49.4	30.2	33.7	45.3	24.1	43.2
10	44.3	40.9	45.3	49.5	37.7	42.5	31.8	32.7	17.9	8.8	43.0	40.6
11	31.2	44.8	41.2	42.9	30.1	33.8	27.2	21.4	40.1	15.7	28.4	34.8
12	37.7	46.8	49.5	52.3	43.3	35.6	27.3	28.5	27.2	20.1	21.3	42.1
13	44.1	45.7	49.6	43.5	41.7	34.0	33.5	35.8	44.6	42.8	9.0	42.7
14	34.4	45.1	22.9	52.5	29.0	39.2	24.9	35.1	32.0	48.2	21.5	36.3
15	33.7	48.7	43.7	46.9	32.5	33.1	17.7	28.3	27.9	33.3	27.2	37.9
16	33.6	43.9	30.9	38.5	35.6	35.0	33.7	32.8	26.6	37.8	28.3	33.7
17	37.9	42.2	37.1	31.2	38.3	12.2	20.7	41.1	33.8	36.4	14.7	36.7
18	33.2	44.7	43.0	44.7	27.4	30.6	24.5	39.4	28.7	21.5	22.0	44.3
19	38.5	37.2	42.5	34.9	41.0	40.7	34.0	21.1	24.9	16.9	33.2	45.3
20	41.2	43.4	44.6	37.6	17.8	35.4	26.7	23.7	34.7	37.9	42.6	44.1
21	37.3	39.2	36.7	39.1	25.5	37.8	32.9	37.4	52.3	35.3	24.1	39.3
22	40.3	43.4	13.0	21.1	22.7	37.3	24.5	38.6	41.3	18.8	19.6	41.2
23	41.3	23.1	15.2	30.7	40.1	26.1	45.3	24.8	21.8	18.6	5.9	41.2
24	35.7	42.0	47.7	26.4	33.8	21.4	24.6	35.0	37.5	23.0	23.8	39.0
25	37.0	44.2	36.4	29.7	25.8	24.6	27.2	32.3	35.7	48.5	39.3	41.7
26	36.5	41.5	41.3	17.5	31.9	38.0	21.3	26.5	18.7	26.5	24.5	38.7
27	43.4	47.4	52.5	16.3	6.0	31.7	44.0	28.2	44.0	29.7	33.1	38.0
28	44.5	39.6	47.1	35.4	46.2	42.7	32.4	46.6	51.7	33.4	26.4	37.1
29	41.3		51.8	49.4	42.9	26.7	38.1	25.7	29.5	23.1	31.6	38.9
30	43.5		48.0	41.4	34.8	22.0	33.8	29.7	41.3	24.8	17.1	38.6
31	25.3		44.7		55.0		22.3	48.1		36.9		38.7



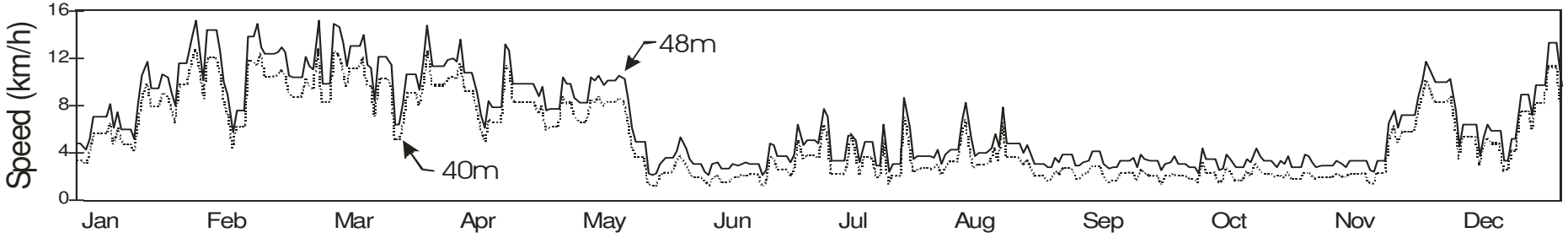
Total Monthly Solar Radiation

	Long-term Average (1988-2001)				2002	
	PAR (Einsteins m^{-2} day^{-1})		Pyranometer (KJ m^{-2} day^{-1})		PA R	Pyran.
	Mean	S.D.	Mean	S.D.		
January	**37.3**	**5.1**	**18116**	**1427**	**35.4**	**16097**
February	**41.2**	**4.9**	**20050**	**1043**	**41.7**	**18956**
March	**42.7**	**3.5**	**21291**	**1239**	**42.1**	**19167**
April	**40.3**	**3.3**	**19883**	**947**	**37.7**	**16612**
May	**31.6**	**3.7**	**15683**	**1484**	**34.4**	**16067**
June	**28.2**	**3.6**	**14064**	**1092**	**30.8**	**13291**
July	**28.4**	**3.4**	**14190**	**1224**	**32.2**	**13768**
August	**28.9**	**3.7**	**14566**	**1387**	**30.7**	**13677**
September	**29.0**	**3.3**	**14823**	**1144**	**34.3**	**14670**
October	**27.2**	**4.7**	**13784**	**1580**	**29.3**	**13042**
November	**24.0**	**7.8**	**13068**	**1068**	**26.0**	**11197**
December	**28.0**	**6.0**	**14536**	**2391**	**38.2**	**16985**



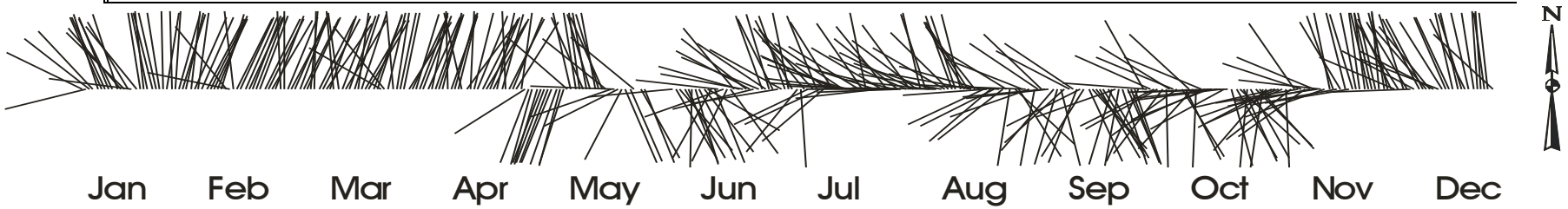
Daily Average Wind Speed (km/h)

	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sep.		Oct.		Nov.		Dec.	
	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m	40m	48m
1	3.4	4.8	8.6	10.1	12.8	15.1	9.7	11.3	8.3	9.9	2.0	3.1	3.8	5.0	2.2	3.1	2.8	3.9	1.9	2.8	1.9	2.9	8.3	10.0
2	3.4	4.8	12.1	14.3	8.3	9.8	10.3	11.8	8.3	9.9	2.0	3.1	3.6	4.8	2.8	3.9	2.8	3.9	1.9	2.8	2.0	3.0	8.3	10.0
3	3.1	4.2	12.1	14.3	8.3	9.8	10.5	11.9	7.1	8.7	2.0	3.1	6.4	7.7	3.3	4.3	1.9	3.0	1.5	2.3	2.0	3.0	8.3	10.0
4	4.1	5.2	12.1	14.3	8.3	9.8	10.2	11.7	6.6	8.3	1.7	2.5	5.7	7.0	3.3	4.3	1.9	3.0	3.3	4.5	2.0	3.0	8.8	10.3
5	5.6	7.0	10.6	12.6	12.6	14.9	11.6	13.5	6.6	8.3	1.3	2.2	2.3	3.4	3.3	4.3	2.3	3.2	2.4	3.4	2.0	3.0	6.6	7.5
6	5.6	7.0	8.2	9.9	12.3	14.6	9.3	10.8	6.6	8.3	1.9	3.1	2.3	3.4	5.4	6.7	2.4	3.3	2.4	3.4	2.2	3.3	3.5	4.5
7	5.6	7.0	7.2	8.9	11.3	13.3	9.3	10.8	8.6	10.4	2.1	3.3	2.3	3.4	6.9	8.3	2.9	4.1	2.4	3.4	2.1	3.0	5.4	6.4
8	5.6	7.0	4.4	5.7	9.6	11.3	9.3	10.8	8.3	10.1	1.6	2.7	2.3	3.4	4.1	5.3	2.9	4.1	1.6	2.6	1.9	2.8	5.4	6.4
9	6.5	8.1	6.3	7.6	11.2	13.0	7.7	9.0	8.8	10.6	1.6	2.7	3.1	5.4	2.7	3.8	2.9	4.1	1.7	2.7	2.3	3.3	5.4	6.4
10	4.8	6.1	6.3	7.6	11.2	13.0	6.1	7.2	8.0	9.7	1.6	2.7	5.7	5.4	3.1	4.1	2.0	3.0	2.8	3.9	2.3	3.3	5.4	6.4
11	6.1	7.4	6.3	7.6	11.2	13.0	5.0	6.2	8.3	10.2	1.9	3.1	3.8	5.1	3.1	4.1	1.5	2.7	2.4	3.4	2.3	3.3	2.9	3.7
12	4.8	6.0	11.8	13.8	12.0	14.0	6.9	8.4	8.3	10.2	2.0	3.0	2.2	3.2	3.1	4.1	1.7	2.8	1.7	2.8	2.3	3.3	4.4	5.4
13	4.8	6.0	11.8	13.8	9.7	11.5	6.6	7.9	8.3	10.2	2.2	3.1	3.7	4.9	3.3	4.5	1.7	2.8	1.7	2.8	2.3	3.4	5.3	6.4
14	4.8	6.0	11.4	14.9	9.7	11.2	6.6	7.9	8.7	10.5	2.1	3.2	3.7	4.9	4.4	5.6	2.3	3.4	1.7	2.8	1.5	2.5	4.8	5.8
15	4.1	5.3	12.4	13.0	7.1	8.4	6.6	7.9	8.4	10.2	2.2	3.2	3.7	4.9	3.4	4.6	2.3	3.4	2.5	3.5	1.5	2.4	4.8	5.8
16	6.8	8.1	10.4	12.3	10.3	12.1	11.4	13.1	7.0	8.6	2.2	3.2	1.9	3.0	6.6	7.8	2.3	3.4	2.1	3.2	2.3	3.3	4.8	5.8
17	8.8	10.5	10.4	12.3	10.3	12.1	11.0	12.6	4.6	6.1	2.2	3.2	2.1	3.0	3.7	4.8	2.4	3.6	3.2	4.4	2.3	3.3	2.6	3.4
18	9.9	11.7	10.4	12.3	10.3	12.1	8.3	9.8	3.6	4.9	1.2	2.1	5.1	6.4	3.7	4.8	1.7	2.8	2.6	3.7	2.3	3.3	2.6	3.4
19	7.9	9.4	10.5	12.5	9.8	11.5	8.3	9.8	3.6	4.9	1.5	2.6	1.4	2.4	3.7	4.8	2.6	3.8	2.3	3.4	5.3	6.6	4.2	5.2
20	7.9	9.4	11.0	13.0	5.1	6.4	8.3	9.8	3.6	4.9	3.7	4.9	2.1	3.1	3.7	4.8	2.3	3.5	2.3	3.4	6.3	7.6	4.2	5.2
21	7.9	9.4	10.6	12.5	5.1	6.4	8.3	9.8	1.4	2.4	3.4	4.7	2.1	3.1	3.0	4.0	2.1	3.3	2.3	3.4	4.9	6.2	7.6	9.0
22	9.1	10.7	9.0	10.5	6.7	8.1	8.3	9.8	1.3	2.1	2.6	3.7	2.1	3.1	3.5	4.7	2.1	3.3	2.0	2.9	5.7	7.2	7.6	9.0
23	8.8	10.4	8.8	10.4	9.1	10.7	8.3	9.8	1.2	2.3	2.6	3.7	7.1	8.6	2.8	3.9	2.1	3.3	2.2	3.3	5.7	7.2	7.6	9.0
24	7.7	9.1	8.8	10.4	9.1	10.7	7.4	8.8	2.1	3.1	2.6	3.7	5.2	6.3	2.0	3.1	1.4	2.5	1.9	3.0	5.7	7.2	6.0	7.1
25	6.6	8.0	8.8	10.4	9.1	10.7	8.0	9.6	2.4	3.6	2.1	3.2	2.4	3.5	2.0	3.1	2.1	3.1	2.4	3.7	5.7	7.2	8.2	9.7
26	9.8	11.6	10.3	12.1	8.0	9.3	6.0	7.5	2.4	3.6	2.8	3.9	2.6	3.8	2.0	3.1	2.1	3.2	1.8	2.8	7.5	8.9	8.2	9.7
27	9.8	11.6	9.6	11.3	10.1	11.6	6.2	7.8	2.4	3.6	5.1	6.3	2.7	3.7	1.7	2.8	2.3	3.7	1.8	2.8	8.5	9.9	8.2	9.7
28	9.8	11.6	9.4	11.0	12.6	14.7	6.2	7.8	3.3	4.2	3.6	4.7	2.7	3.7	1.8	2.8	2.0	3.2	1.8	2.8	10.1	11.7	11.3	13.3
29	11.8	13.8			9.7	11.3	6.2	7.8	3.8	5.4	3.8	5.0	2.7	3.7	2.5	3.6	2.0	3.2	2.4	3.8	9.4	11.0	11.3	13.3
30	12.8	15.2			9.7	11.3	8.8	10.4	3.2	4.4	3.8	5.0	2.7	3.6	2.3	3.3	2.0	3.2	2.4	3.8	8.3	10.0	11.3	13.3
31	10.9	12.7			9.7	11.3			2.5	3.4			3.1	4.2	2.8	3.9			2.1	3.3			7.9	9.6



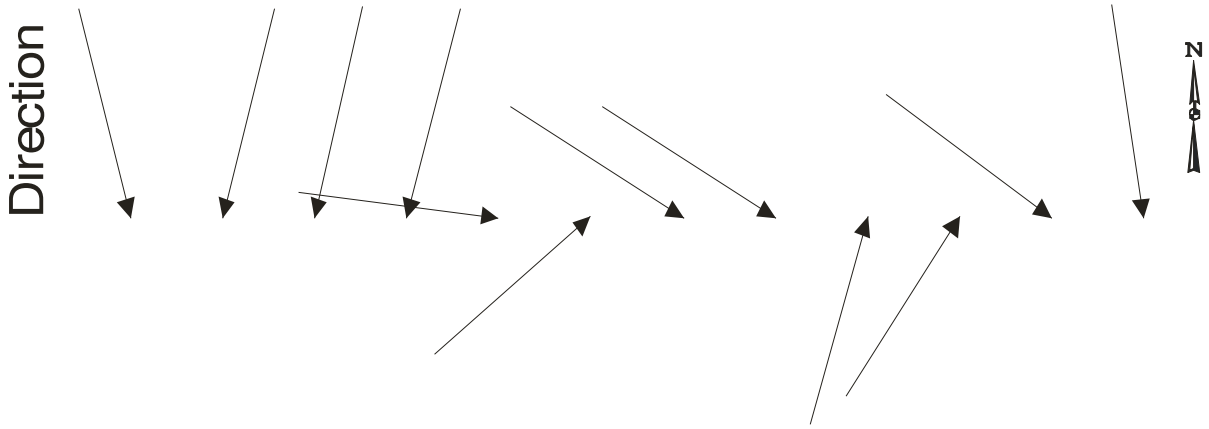
Average Daily Wind Direction

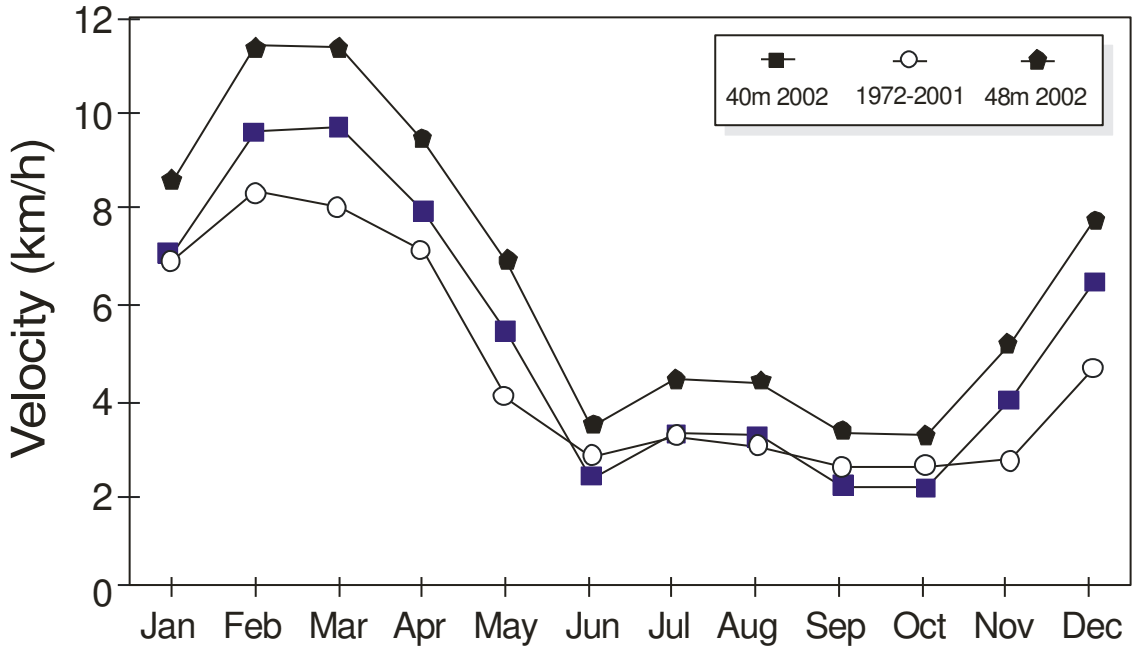
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	298	22	23	22	199		301	268	293	202	139	348
2	255	26	5	11	200		342	296	272	333	188	355
3	310	25	1	18	201	265	349	326	250	275	219	352
4	319	24	25	17	198	152	333	298	189	296	241	347
5	343	20	26	13	194	142	216	309	306	242	256	336
6	338	15	32	359	197	151	176	347	316	240	249	295
7	337	323	18	18	313	159	322	343	264	215	245	330
8	339	283	355	14	348	181	243	277	263	178	178	344
9	336	354	353	13	352	164	320	290	218	303	231	331
10	343	7	19	347	353	155	340	271	195	294	327	268
11	322	17	28	34	338	144	243	282	167	233	260	300
12	316	23	18	3	350	122	228	302	226	151	290	335
13	331	23	17	13	344	207	310	316	300	155	233	335
14	278	24	8	20	351	159	331	341	306	316	258	322
15	323	20	17	25	345	277	296	342	200	221	294	323
16	353	19	28	29	338	249	294	347	242	183	261	299
17	354	19	28	21	310	204	306	331	211	295	277	293
18	349	25	20	24	250	146	289	331	156	244	250	330
19	347	25	17	12	272	322	278	281	139	247	350	338
20	348	28	302	15	242	287	275	323	144	268	342	337
21	352	19	323	358	206	282	303	287	151	263	259	347
22	359	358	12	25	159	310	327	243	150	262	331	348
23	8	1	357	21	157	299	349	266	151	240	347	344
24	359	21	9	30	312	255	273	228	195	268	260	335
25	4	26	11	8	168	295	290	243	249	166	344	348
26	14	21	11	236	153	342	263	273	190	151	349	352
27	15	20	30	199	160	306	302	230	164	135	352	357
28	12	25	24	195		344	323	304	157	157	353	357
29	6		16	195		335	270	189	161	185	348	353
30	22		19	199		260	285	134	162	153	348	353
31	7		19				311	150		138		315



Average Monthly Wind Speed and Direction

	Long-term Av. (1972-2001)			2002	
	Speed	S.D.	Direction	Speed	Direction
January	6.9	1.1	357.3	7.1	345.3
February	8.4	1.3	4.9	9.3	16.0
March	8.0	1.0	1.5	9.7	13.7
April	7.1	1.5	353.3	8.2	15.2
May	4.0	1.2	305.9	5.6	276.5
June	2.8	0.6	271.3	2.4	230.9
July	3.2	0.8	310.2	3.3	301.2
August	3.0	0.6	264.9	3.3	300.8
September	2.6	0.3	221.4	2.1	196.6
October	2.6	0.3	221.0	2.2	214.3
November	2.8	0.3	260.6	3.9	304.7
December	4.7	1.1	333.6	6.5	351.0





Estimated Evapotranspiration and Water Balance

Average (1993-2001)	'El Claro'			'40m'			'48m'		
	Month^{-1}	Day^{-1}	S.D.	Month^{-1}	Day^{-1}	S.D.	Month^{-1}	S.D.	Day^{-1}
January	87.8	2.8	0.6	141.6	2.8	0.6	-	-	-
February	108.4	3.9	0.7	154.2	3.9	0.7	-	-	-
March	131.4	4.2	0.7	183.3	4.2	0.7	-	-	-
April	114.3	3.8	0.4	160.8	3.8	0.4	-	-	-
May	78.1	2.5	0.8	108.4	2.5	0.8	-	-	-
June	53.1	1.8	0.5	81.9	1.8	0.5	-	-	-
July	59.5	1.9	0.2	84.3	1.9	0.2	-	-	-
August	60.1	1.9	0.3	89.9	1.9	0.3	-	-	-
September	61.3	2.0	0.3	85.8	2.0	0.3	-	-	-
October	62.1	2.0	0.3	88.8	2.0	0.3	-	-	-
November	45.3	1.5	0.5	71.2	1.5	0.5	-	-	-
December	52.4	1.7	0.5	90.0	1.7	0.5	-	-	-

2002	Evapotranspiration (mm eq. day^{-1})			Net Water Balance (mm eq. day^{-1})		
	'El Claro'	40 m	48 m	'El Claro'	40 m	48 m
January	**3.6**	**5.0**	**6.1**	**-2.1**	**-3.4**	**-4.5**
February	**4.6**	**5.7**	**6.2**	**-4.8**	**-6.0**	**-6.6**
March	**5.0**	**5.2**	**6.1**	**-3.5**	**-3.7**	**-4.6**
April	**4.1**	**5.2**	**5.7**	**0.6**	**-0.6**	**-1.1**
May	**3.8**	**4.2**	**4.6**	**3.0**	**2.6**	**2.2**
June	**2.1**	**2.5**	**2.5**	**4.9**	**4.6**	**4.5**
July	**2.5**	**3.0**	**3.3**	**7.0**	**6.5**	**6.2**
August	**2.3**	**2.6**	**2.9**	**5.9**	**5.5**	**5.3**
September	**2.9**	**3.1**	**3.4**	**0.9**	**0.6**	**0.4**
October	**2.2**	**2.8**	**2.7**	**1.6**	**1.1**	**1.1**
November	**1.8**	**2.6**	**2.5**	**3.9**	**3.1**	**3.2**
December	**4.0**	**5.3**	**5.3**	**-2.7**	**-4.0**	**-3.9**

Estimated Evapotranspiration and Water Balance